Department of Education
Federal Student Aid
Chief Information Office
Electronic Commerce Applications Development

QUALITY ASSURANCE HANDBOOK (FINAL)

Standards and Procedures

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FOREWARD

BSC Systems, Inc. would like to thank those involved in the development of this document.

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EXECUTIVE SUMMARY

This revised handbook has been prepared for the Department of Education, Federal Student Aid organization (FSA). FSA has embarked upon an ambitious program to provide state-of-the-art information access to its user population: students, financial institutions, and financial professionals at learning institutions. Due to the extensive user demographics as well as the visibility of the program, FSA decided to impose the rigors of Independent Verification and Validation (IV&V) upon critical software application developments. As a pioneer Performance Based Organization, FSA desires to establish standards and criteria with which to measure the performance of its IV&V agents.

The first iteration of the QA Handbook was released last year and provided detailed standards and procedures for IV&V and IV&V related Security Assessments. This update reflects:

- Adoption by FSA of the Solution Life Cycle (SLC) development methodology
- A refining of IV&V "best practices" to the FSA environment
- An approach for "tailoring" IV&V approaches to reflect life cycle methodology, traditional versus accelerated development, centralized versus Internet development environments, and externally imposed constraints, such as budget limitations
- Standards and procedures to reflect renewed security awareness and address security effectiveness evaluations beyond the scope of traditional IV&V security evaluations

The IV&V approach presented in this handbook facilitates a team-building relationship between the developers and IV&V staff. The approach features open lines of communication and cooperation between the two groups while maintaining absolute independence and objectivity of and by the IV&V staff. This approach is facilitated through risk based monitoring of the targeted processes and products in a structured manner and features timely communications of findings to the development organization.

This handbook is structured to include standards and procedures for:

- Conducting IV&V Reviews
- Security Effectiveness Evaluations
- IV&V Reporting
- IV&V Performance Measures

Each of these standards and procedures has been combined into this Quality Assurance Handbook. The purpose of this handbook is to establish standards and procedures for conducting IV&V and assessing the information security of designated FSA systems under development and in production.

TABLE OF CONTENTS

Page

TABLE OF CONTENTS (Cont'd)

Page

TABLE OF CONTENTS (Cont'd)

Page

LIST OF EXHIBITS

LIST OF ACRONYMS

ACL	Access Control List
BC	Business Case
BSI	British Standards Institute
CCB	Configuration Control Board
CDR	Critical Design Review
CIO	Chief Information Office
CM	Configuration Management
CMM	Capability Maturity Model
COCOMO	Constructive Cost Model
COTS	Commercial Off-The-Shelf
DAA	Designated Approving Authority
EASI	Easy Access for Students and Institutions
ECAD	Electronic Applications Development Division
ED	Department of Education
EDI	Electronic Data Interchange
ESVA	Environment Security Vulnerability Analysis
FCA	Functional Configuration Audit
FEDSIM	Federal Systems Integration Management Center
FIPS	Federal Information Processing Standard
FSA	Federal Student Aid
GFE	Government Furnished Equipment
GSS	General Support System
HCI	Human Computer Interface
HTTP	Hypertext Transfer Protocol
ID	Identification
IP	Internet Protocol
IPR	In Process Review
IPT	Integrated Product Team
ISACA	Information Systems Audit and Control Association
ISO	International Standards Organization
IT	Integration Test
IQA	Independent Quality Assurance
IV&V	Independent Verification & Validation

LIST OF ACRONYMS (Cont'd)

KPA	Key Process Area
NIST	National Institute of Standards and Technology
OSI	Open Systems Interconnect
PBO	Performance Based Organization
PCA	Physical Configuration Audit
PDL	Program Design Language
PDR	Preliminary Design Review
PRR	Production Readiness Review
QA	Quality Assurance
RAD	Rapid Application Development
RDM	Requirements Database Model
REVIC	Revised COCOMO
RMA	Reliability, Maintainability, and Availability
ROI	Return on Investment
RTM	Requirements Traceability Matrix
RVM	Requirements Verification Matrix
SA	Security Assessment
SAP	Solution Acquisition Plan
SAPM	Solution Acquisition Project Management
SAT	Security Assessment Team
SDF	Software Development Folder
SI&T	System Integration and Test
SLC	Solution Life Cycle
SLOC	Source Lines of Code
SOO	Statement of Objectives
S&P	Standards and Procedures
SQL	Standard Query Language
SRR	System Requirements Review
SSO	Single Sign-On
ST&E	Security Test & Evaluation
TRR	Test Readiness Review
TTS	Transition to Support
WBS	Work Breakdown Structure

1. INDEPENDENT VERIFICATION & VALIDATION HANDBOOK

1. GENERAL INTRODUCTION

This Quality Assurance Handbook was developed to establish standards and procedures for conducting Independent Verification and Validation (IV&V) reviews and security assessments of information technology systems supporting the Federal Student Aid (FSA), U.S. Department of Education (ED).

These standards and procedures were developed and tailored using relevant portions of Federal Information Processing Standards (FIPS) Publication 132, "Guideline for Software Verification and Validation Plans" as a guide for IV&V and National Institute of Standards and Technology (NIST) Special Publication 800-18, "Guide for Developing Security Plans for Information Technology Systems," NIST Special Publication 800-14, "Generally Accepted Principles and Practices for Securing Information Technology Systems," and NIST Special Publication 800-26, "Security Self Assessment Guide for Information Technology Systems" as a guide for security assessments.

Execution of IV&V and security assessment reviews that follow the accompanying guidelines will help to insure that IV&V and security assessment teams can consistently meet the quality and performance requirements of FSA in an effective, timely and cost effective manner. In addition, adherence to these IV&V and security assessment guidelines will accomplish these specific objectives:

- Providing objective system development and security assessment appraisals
- Adherence to Federal guidance governing management and review of systems development and security assessment activities
- Increased design phase visibility
- Early problem identification and remediation strategy development
- Reduce risk associated with systems development
- Reduce security threats and vulnerabilities to systems throughout the Solution Life Cycle (SLC)
- Improved system maintainability, reliability and integrity

The QA Handbook is organized as follows:

- Section 1 is an Introduction to IV&V and Security Assessment.
- Section 2 covers Independent Verification and Validation Standards.
- Section 3 covers Independent Verification and Validation Procedures.
- Section 4 covers Security Assessment Standards and Procedures.
- Section 5 covers Reporting Standards and Procedures for both IV&V and Security Assessment.

- Section 6 covers Performance Standards and Procedures for both IV&V and Security Assessment.

1.1 Introduction to Independent Verification and Validation

Independent Verification and Validation is a process, independent of the development organization, used to assure that the products of a software development activity meet the requirements of that activity and that the delivered software satisfies the intended use and user needs as described to the developer.

Verification ensures that standard procedures and practices as defined in the FSA Solution Life Cycle (SLC) Process Guide are followed. Requirements are verified and development products are evaluated against defined requirements. Deliverables are examined to ensure that they are standardized as applicable under the SLC, are accurate, and are delivered in a timely fashion.

Validation ensures that all requirements are adequately tested or demonstrated, and that test results are as expected and can be repeated to verify correct implementation of approved changes.

Execution of a plan that follows these guidelines will help to ensure that the IV&V Team can consistently meet the day-to-day quality and performance requirements of FSA in a timely and cost-effective manner. Performance of these IV&V activities results in accomplishing the following:

- An objective system development appraisal
- A baselined set of testable requirements that match the user's needs
- Increased design phase visibility
- Early potential problem area indication
- Development risk reduction
- Improved maintainability and reliability

1.1.1 Scope

This IV&V Handbook describes the activities to be conducted for the FSA Modernization Program. The IV&V Team will perform IV&V activities for each target system as directed by FSA.

These standards and procedures are appropriate for application to software acquired or developed by FSA. These IV&V standards and procedures will describe the following:

- Verification of program development products and processes and evaluation of each product against all previous development phase product requirements
- Validation that the completed end product complies with established software and system requirements
- Guidance for tailoring IV&V activities based on life cycle methodology, development environment, and externally imposed constraints

For each target system to undergo IV&V, it is recommended that a project-specific IV&V Plan be prepared that briefly specifies the target system profile, organization of the IV&V Team, scope of the IV&V effort, points of contact for all parties, and tailoring of any IV&V tasks or checklists.

1.1.2 FSA Modernization Program

The FSA Modernization Program organization is designed to provide management visibility into the technical work areas and ensure effective lines of authority, supervision, and communication. These standards and procedures describe the Independent Quality Assurance (IQA) project organization, detail the authority and the specific responsibilities for IV&V throughout a target system life cycle, and identify the specific resources necessary to perform the IV&V and security assessment tasks effectively.

Functionally and organizationally, the Chief Information Office (CIO) has overall responsibility for instituting and leading the QA approach for FSA target systems. However, the Deputy CIO Electronic Applications Development Division (ECAD) teams have the responsibility to support and provide guidance in the areas of standard practices, procedures, and guidelines in these efforts. The Integrated Product Teams (IPT) will have delegated responsibility for QA practices as applicable.

1.1.3 IV&V Requirement and Justification

The Clinger-Cohen Act of 1996 was passed in response to federal audits that consistently found that waste, fraud, abuse, and mismanagement of IT resources were often the result of an inadequate investment process, investment decisions based on unreliable data, and a failure to understand that IT investments must show actual returns in order to pay dividends. In addition, the act was an attempt to reduce an excessive documentation approval process and an overlong acquisition cycle. The legislation is based on proven best practices that are used in the IT industry to improve performance and meet strategic goals. This, in turn, should ensure project completion within schedule, at acceptable costs, and with positive Return On Investment (ROI).

A major provision of the Clinger-Cohen Act calls for performance and results-based management in order to increase the focus on process improvement among other strategic improvements. One of the recommended techniques for this, as described in the "Project Management Handbook for Mission Critical Systems: A Handbook for Government Executives," is "to outsource for independent validation and verification (IV&V) support." The Handbook goes on to state "it is critical for the executive leadership to listen to IV&V advice."

It is difficult to assign dollar numbers and cost effectiveness to IV&V for software development in terms of doing traditional ROI calculations because the process does not lend itself to these measures and very few organizations have built a database of historical metrics that allow for comparisons between similar projects. The kinds of questions that have to be answered in building such a database would include:

- Would the developer have found the same problems?
- If so, when would they have been found and what would have been the cost of correction?
- What would the costs have been in terms of customer impact if the defects had not been detected?

One of the few attempts to answer these questions has been a case study* conducted by NASA that compared two similar projects. One involved IV&V throughout the entire life cycle, and the other was a project that used IV&V in a partial life cycle (meaning one or more pre code and development phases were not supported by IV&V). This study determined that the project fully supported by IV&V resulted in a reduction in defects of almost two-thirds compared to the project that was partially supported. The study then went on to estimate the ROI of IV&V as being between 1.25:1 and 1.82:1.

Other reported studies on ROI of IV&V efforts are all from the defense industry and are based on rework cost avoidance. They range from an ROI of 4.5:1 reported by Hughes to an ROI of 7:1 reported by Raytheon. **

Important benefits of IV&V also mentioned in the NASA report but not included in ROI calculations are:

- The "watchdog effect" that is recognized as encouraging the developer to be more conscientious and more likely to exercise greater care
- Improved maintainability because of the increased accuracy, readability, and maintainability of system documentation
- Better understanding of and response to risks

These benefits, although not quantifiable, may actually outweigh the benefits of the calculated ROI.

* "A Case Study of IV&V Return on Investment (ROI)," Titan Systems Corporation, Averstar Group.

** "V&V Research Quarterly" Volume 5, Number 4 October 1998

1.1.4 IV&V Process

The IV&V process is part of the systems engineering function and provides objective data and recommendations concerning software quality, software performance, and schedule compliance to the Modernization Partnership Team. The IV&V process can include analysis, evaluation, review, inspection, assessment and testing of software products and processes within the context of the system.

IV&V is an extension of the program management and systems development team and is best accomplished using a team-building approach. There is a natural dynamic tension for the IV&V

Team between the maintainting objectivity through organizational independence and remaining a constructive part of the team effort in building quality into the software and the development process. The team-building approach to IV&V is described in greater detail in Section 2.

1.1.5 Independence of IV&V

IV&V independence is established through four mechanisms: technical independence, managerial independence, financial independence, and contractual independence.

- Technical independence requires that IV&V personnel not be involved in any stage of the software development process.
- Managerial independence requires that IV&V responsibility be vested in an organization that is separate from the development and program management organizations. The independent selection of the artifacts to be examined and tested, the techniques to be used, the issues to be chosen, and the reporting to be made further affirm this independence.
- Financial independence requires that the IV&V budget be vested in an organization independent from the development organization.
- Contractual independence requires that the IV&V contract be executed separately from the contract for development.

Classical IV&V independence is achieved when all four parameters exist by vesting the IV&V authority in an organization separate from the development organization. This requires that the IV&V organization establish a close working relationship with the development organization while maintaining an independent role.

1.1.6 IV&V Purpose and Goals

The IV&V Program objective is to provide an independent system assessment by analyzing and testing the target system to assure that it performs its intended functions correctly, to ensure that it performs no unintended functions, and to measure its quality and reliability. These standards and procedures describe the overall concept and management approach for IV&V and define the responsibilities required to conduct an effective IV&V program.

The intent of verification and validation is to improve the quality of the software during the life cycle process, not afterwards, and it must be performed at the same time as the software development. It should be done in a manner that provides early feedback to the development organization, allowing modifications to processes and products in a timely fashion. This proactive, but independent, approach, as compared to an auditing or adversarial approach, results in fewer delays, reduced cost, higher product quality, and improvement of the development process itself.

The focus of the IV&V standards and procedures is on successful execution of independent verification and validation activities required to ensure the procurement, integration and implementation of high quality new software and upgrades for FSA target systems. IV&V activities strive to ensure that quality is built into the system and that it satisfies user

requirements. IV&V provides insights into the status of the development activity, allowing for timely correction of identified defects in the products or in the development processes. IV&V employs review, analysis and testing techniques to determine whether a system complies with requirements. These requirements include both functional and performance capabilities defined in the system specifications as well as quality attributes. Quality attributes are identified as those which serve the user's need for a product that is capable of meeting its objectives. Additionally, the IV&V activities endeavor to ensure that products provided by the developer will provide the Department of Education with the software and associated documentation necessary to facilitate future enhancements. Key elements that serve as a foundation for effective IV&V include:

- Domain knowledge
- Rigorous implementation of well-defined analysis processes and procedures
- Structured and thorough assessments
- Correct identification of critical system functions to enable focusing on areas that benefit the most from IV&V, especially critical for rapid application development
- Effective management of performance objectives

Corrections of deficiencies identified during the verification process are evaluated to the lowest applicable level to ensure the integrity of the requirements, design, code, and test evolution. The validation process ensures that all requirements are adequately tested or demonstrated, and that test results are as expected and can be repeated to verify correct implementation of approved changes. Performing IV&V as defined in these standards and procedures provides for a comprehensive evaluation throughout each phase of the target system to help ensure that:

- Errors are detected and corrected as early as possible in the software life cycle
- Project risk, cost, and schedule effects are lessened
- Software quality and reliability are enhanced
- Management visibility into the software process is improved
- Proposed changes and their consequences can be quickly assessed

1.1.7 Assumptions

It is assumed that the IV&V Team has continuous access to developer documentation, status information, configuration management (CM) data, test results, and anomaly data. The IV&V Team requires early, complete and continuous visibility into the development effort. The IV&V Team must be exposed to all aspects, both formal and informal, of the development effort in order to perform an adequate and accurate assessment. Often, informal processes constitute the essence of a development effort, and observation and participation in these activities by the IV&V Team is beneficial to both parties. The IV&V Team gains technical insight and can capture information that may not be formally documented, and the development team can often benefit from the input of additional qualified technical personnel. The IV&V Team also provides a unique perspective that is not only more objective but also focused on the end goals of the development.

These IV&V standards and procedures are designed to augment the development effort while minimizing interference. In order to implement these standards and procedures, the IV&V Team

assumes that, for automated IV&V activities, the required magnetic media documentation, as well as requirements traceability, code analysis, and design evaluation automated tools are available.

1.1.8 Tailoring

These IV&V standards and procedures are a "plan" and will be tailored as appropriate for each target system development. Tailoring of these standards and procedures is to be done by the IV&V Team in consultation with each respective FSA organization. The tailoring effort shall include definition of the acceptable level of risk and identification of those software components that are considered critical. The IV&V tasks and procedures may be tailored depending upon the type of system being developed (i.e., new or already deployed), the software development methodology, or the actual software being implemented by the developer (e.g., new code versus reused code). Other factors to consider are the use of an accelerated development, COTS-based development, or custom development.

1.2 Introduction to Security Assessment

Traditionally, security assessment is an integral element of a comprehensive IV&V assessment and follows the analytical processes for reviewing system functionality and artifacts described in Chapters 1, 2 and 3.

Section 4 of this QA Handbook describes standards and procedures for conducting additional types of security effectiveness evaluations that are beyond the scope of IV&V support efforts. Included are standards and procedures for conducting security engineering studies to evaluate whether appropriate security safeguards are implemented and operating effectively throughout the complete solution life cycle. Security effectiveness evaluations can generally be classified as either:

- Process and artifact reviews
- Detailed technical analysis of the system architecture
- Effectiveness of all or specific security management, operational and technical controls
- Environmental Testing using exploratory techniques directed at probing the vulnerability of the network and/or human components.

Individual subsections describe the standards and procedures for conducting the following types of security evaluations on FSA information systems:

- Security Assessment
- Security Risk Determination
- Architecture Security Assessment
- Environmental Security Vulnerability Analysis

2. INDEPENDENT VERIFICATION AND VALIDATION STANDARDS

The following section describes the IV&V standards, which include the resources, tools, techniques, and methodologies necessary to perform software verification and validation of the target systems. These standards apply to all phases of the software development life cycle as described in the SLC from the Vision Phase to the Support Phase. These standards necessitate the use of mandatory IV&V tasks, while allowing the IV&V Team to tailor their efforts by selecting any of the optional IV&V tasks or identifying new tasks to be performed on the target system.

2.1 IV&V Organization

To ensure the conduct of a quality QA program and timely performance of the prescribed IV&V tasks, the IV&V Team must establish and implement an effective management and control structure. The FSA QA Program Manager will coordinate all IV&V activities, and all formal communications from the FSA Program Office will be routed through the QA Team's Project Manager to the IV&V staff. The IV&V Team's Project Lead will assign tasks and apply the resources necessary to perform these tasks.

The IV&V Team will thoroughly document all IV&V efforts and inform the FSA QA Program Office (as well as the Federal Systems Integration Management Center (FEDSIM)) of their findings as the tasks are performed. Formal evaluations, comments, audit reports and white papers related to IV&V activities will be generated by the IV&V Team and communicated to the developer through the FSA QA Program Office. All deliverables will be prepared and submitted to the FSA QA Program Office via FEDSIM. The IV&V Team will utilize checklists to monitor task performance and product delivery. Examples of the checklists that may be used are included in Appendix A.

At each IV&V phase/iteration, planned IV&V activities will be reviewed and new tasks added as necessary to focus on any critical issues that arise. The QA Project Lead will closely monitor the accuracy and quality of all deliverables and IV&V results, as the development staff must allocate resources to address IV&V findings. By ensuring their accuracy and conciseness, the QA Project Lead will minimize the impact on the developers' time and resources.

The IV&V Team will be responsible for the following activities:

- Supporting the validation of specified requirements and configuration items
- Providing technical analysis of the development effort including metrics analysis
- Performing risk analysis during the development life cycle
- Assisting with the verification of designated data items and products
- Performing requirements and test case traceability analyses
- Monitoring the developer's testing activities
- Preparing and implementing independent test scenarios
- Performing audits of configuration items and processes

- Providing Integrated Product Team support

The above activities will be performed in accordance with the methodology prescribed in these standards and procedures at the direction of the IV&V Program Manager. Most IV&V tasks, with the exception of developer testing, on site audits, and formal reviews will be performed at the IV&V Team's offices. The IV&V Team will provide the hardware and software required for the specific IV&V activities detailed in Section 3. The IV&V Team will interface with members of the target system team as appropriate.

2.2 QA/IV&V Team Oriented Approach

2.2.1 Overview

The IV&V task of software quality improvement in a team-building environment is accomplished by monitoring the targeted processes in a structured manner using proven standards and techniques to objectively identify data and draw concrete conclusions about software quality, performance, and work schedule compliance. These findings are then communicated to the development organization and client through the use of timely and constructive feedback.

As mentioned in Section 1, there is a natural dynamic tension between the independence of the IV&V Team and the promotion of a team-oriented rather than adversarial relationship with the developer. Both the IV&V Team and the development team must accept as the driving principle the idea that the objective is to produce the highest quality software possible. While both teams can be expected to have different perspectives and incentives, this tension can be constructively used to improve both the process and the product. Both teams must remain flexible, stay in close communication, and establish an atmosphere of mutual respect.

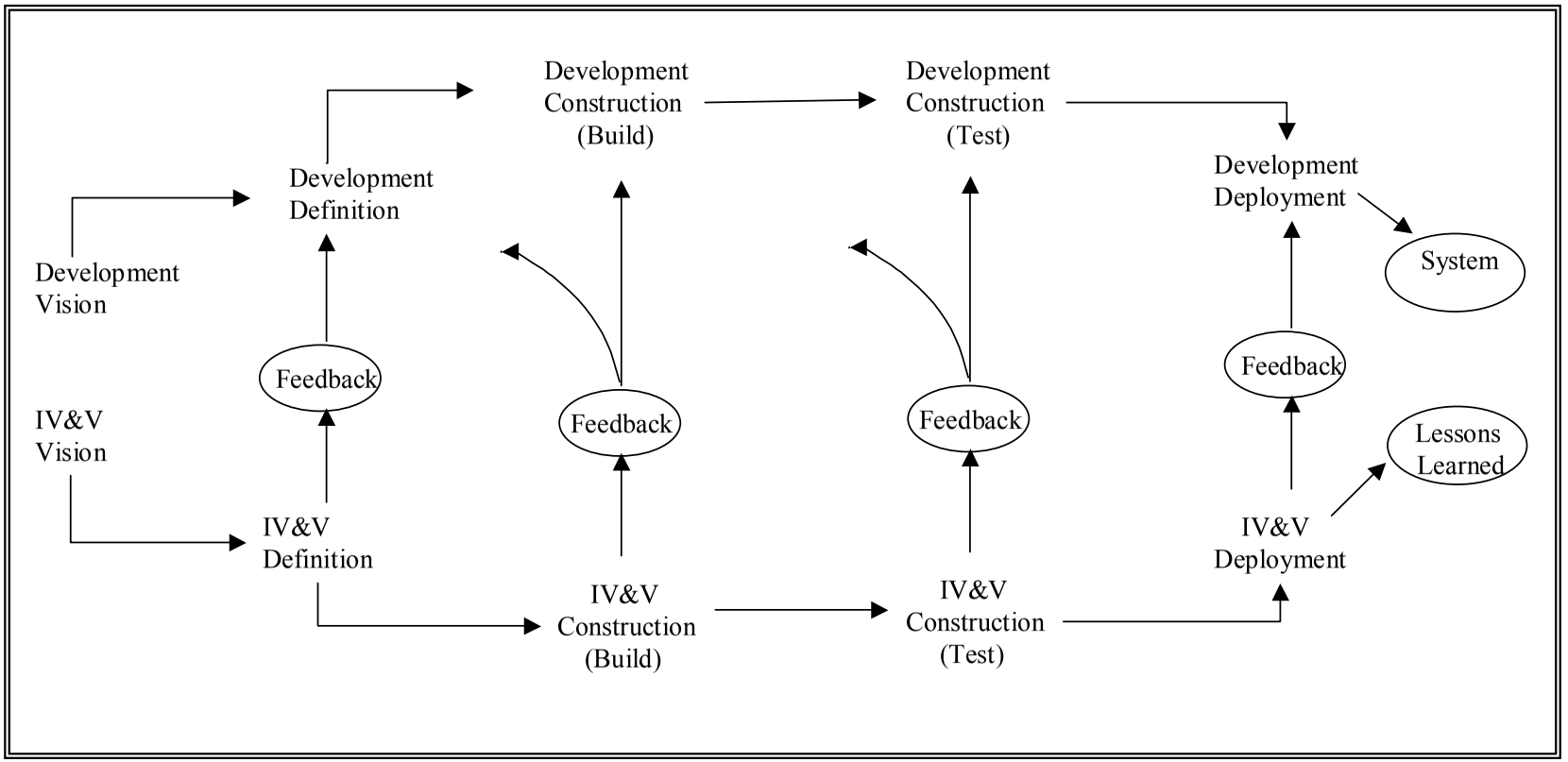
2.2.2 Communication

Team-building in this environment depends on "heads up" communication as opposed to an auditing approach that is intended to identify deficiencies and will, inevitably, provide late feedback. This "heads up" approach is accomplished by means of feedback that is timely, relevant, constructive, and aimed at improving the process of development during the life cycle. The objective is to build trust, not destroy it. There are several means of providing feedback to the development team and the client organization. These may include, but are not limited to, e-mail alerts, status reports, issue lists, a risk watch list and formal findings such as the End of Phase Report. Informal verbal comments and briefings on minor process items, such as suggestions for additional methods or improvements, may also be appropriate but should be documented for the IV&V customer. This communication approach lays the groundwork for building rapport between the developers and the IV&V team. The communication methods used are largely determined by the development methodology being used and the degree of impact of the findings involved.

It is vitally important that these findings and recommendations be provided to the development organization in a manner and format that allows the developer to rapidly integrate them into the

development process. They should be prioritized in terms of impact, relevance, and audience so that the appropriate member of the development team can focus on the most important issues first. Minor issues, such as recurring typos or minor documentation errors, should be summarized rather than presented as a series of issues so they do not obscure the more important findings. This feedback process is iterative and spans the development life cycle but does not substitute for entrance and exit criteria at predetermined points in the life cycle. Exhibit 2-1 shows the parallel tracks of development and IV&V activities through the first four stages of the SLC. Arrows indicate the IV&V feedback that applies to the parallel development stage and previous development stages.

In those rare instances where this approach to process improvement is not possible, it may be necessary to adopt a more traditional auditing approach to IV&V that focuses on documenting deficiencies. It should be noted that if this is deemed necessary, it is a warning sign that there is a potentially serious problem with the development project and the customer should be notified of this. It must always be kept in mind that the primary IV&V objective is to protect the client's interests in the development project by providing an independent assessment of the development process and products.



IV&V ITERATIVE FEEDBACK PROCESS
(Showing Parallel Development and IV&V Tracks)

Exhibit 2-1

2.3 Controlling Documents

2.3.1 Solution Life cycle

FSA has implemented a new Solution Life Cycle (SLC) Process Guide that provides a baseline for all solution acquisitions across FSA. The SLC provides the framework to be used from the beginning stages of planning to deployment and support. The SLC Process Guide is based on industry best practices, standard procedures, and tools and reusable components to be used to control projects. The SLC allows FSA personnel and contractors the flexibility to tailor these standard procedures to meet specific needs. The use of these standard procedures will create a uniform set of expectations for all project personnel.

2.3.2 Relevant Federal Guidance

The Clinger-Cohen Act of 1996 was enacted to address many of the problems related to Federal IT management. It requires Federal agencies to focus more on the results achieved through IT investments while concurrently streamlining the IT acquisition process. This act also introduced more rigor and structure into how agencies select and manage IT projects. Among other things the head of each agency is required to implement a process for maximizing the value of the agency's IT investments and assessing and managing the risks of its IT acquisitions.

Section 508 of the Rehabilitation Act Amendments, as amended by the Workforce Investment Act of 1998, requires that any electronic and information technology developed, procured, maintained, or used by Federal agencies will allow Federal employees and members of the public with disabilities to have access to and use of information and data that is comparable to the access to and use of information and data by Federal employees who are not disabled, unless an undue burden would be imposed on the agency. The Act allows for persons affected by it to enforce the law through the use of lawsuits. A set of accessibility standards for the Act has been published by the Architectural and Transportation Barriers Compliance Board as "Electronic and Information Technology Accessibility Standards" and applies to all acquisitions after June, 2001.

"Information Technology Investment Evaluation Guide. Assessing Risks and Returns: A Guide for Evaluating Federal Agencies' IT Investment Decision-Making." GAO/AIMD-10.1.13 February, 1997 – Recommends as part of the IT investment review process that IV&V assessments as a possible source for validating the accuracy, reliability and completeness of systems development status information submitted as input to the Agency IT investment cost-benefit decision making process. In addition, independently derived IV&V assessments are recommended as one possible source of ensuring that project information is valid and that corrective actions have been taken.

2.3.3 Capability Maturity Model (CMM)

Software Capability Maturity Model (SW-CMM). The SW-CMM describes the principles and practices underlying software process maturity and is intended to help software organizations improve the maturity of their software processes in terms of an evolutionary path from ad hoc,

chaotic processes to mature, disciplined software processes. The CMM is organized into five maturity levels:

- Initial. The software process is characterized as ad hoc, and occasionally even chaotic. Few processes are defined, and success depends on individual effort and heroics.
- Repeatable**.** Basic project management processes are established to track cost, schedule, and functionality. The necessary process discipline is in place to repeat earlier successes on projects with similar applications.
- Defined. The software process for both management and engineering activities is documented, standardized, and integrated into a standard software process for the organization. All projects use an approved, tailored version of the organization's standard software process for developing and maintaining software.
- Managed. Detailed measures of the software process and product quality are collected. Both the software process and products are quantitatively understood and controlled.
- Optimizing. Continuous process improvement is enabled by quantitative feedback from the process and from piloting innovative ideas and technologies.

Software Acquisition Capability Maturity Model (SA-CMM). The SA-CMM is a capability maturity model for organizations that acquire or procure software-intensive systems. It is used to assess their maturity and help them improve the systems acquisition process for software intensive systems. The SA-CMM provides acquisition organizations with guidance on how to gain control of their software acquisition processes and helps them to:

- Enhance understanding of software life-cycle activities in relation to system acquisitions
- Benchmark the maturity level of the organization's acquisition process through assessment
- Improve the acquisition processes for software intensive systems
- Set senior management goals for improvement
- Enable prediction of potential acquisition process performance

2.3.4 Other Standards

ISO 9002, “Quality Management Standards and Guidelines,” is a quality assurance model, designed by the International Organization for Standardization, which is made up of quality system requirements. This model applies to organizations that produce, install, and service products. ISO expects organizations to apply this model, and to meet these requirements, by developing a quality system.

ISO 12207, “Software Life Cycle Processes,” offers a framework for software life-cycle processes from concept through retirement. It is especially suitable for acquisitions because it recognizes the distinct roles of acquirer and supplier. In fact, the standard is intended for two-party use where an agreement or contract defines the development, maintenance, or operation of a software system. It is not applicable to the purchase of commercial-off-the-shelf (COTS) software products.

IEEE 1012-1998, “Standard for Software Verification and Validation,” provides industry standards for software verification and validation and defines the specific activities and related tasks.

2.4 Key External Organizations

The IV&V Team must account for important external organizations that affect the development process. In some cases, these organizations may clearly be outside the boundary of the project but have a major interface that has to be monitored. One such example, in the case of FSA projects, is the Virtual Data Center (VDC).

2.4.1 Virtual Data Center

The VDC is responsible for operational issues and has its own procedures that govern these. The VDC also has an important interest in issues of maintainability and configuration management related to operations. The IV&V Team should remain aware of these concerns and ensure that the developer coordinates with the VDC for any issues that cross the boundaries into operations if the target system is to be operated by the VDC.

2.4.2 Other Organizations

The IV&V Team should identify all outside organizations that have a significant impact on the development process and identify the interfaces between these organizations and the development environment. The IV&V Team should then monitor these interfaces to ensure that necessary coordination between the development team and the external organization is carried out appropriately.

2.5 Standards for IV&V Activities

The IV&V Team will perform IV&V by examining the correctness, completeness, reliability, and maintainability of FSA system products at each step in the development process. Correctness means that the product being evaluated satisfies all system specification requirements. Completeness signifies that all required functions are implemented and all necessary products are developed to fully support the program life cycle. Reliability indicates that the final product can be expected to perform its intended function without error or failure. Maintainability requires that the developed program products be designed to facilitate and simplify life cycle maintenance and modification.

The IV&V Team will assess the target based on the type of system model (e.g., web-based or LAN-based) and the current development schedule status. For example, in "new" target systems, the IV&V Team may concentrate upon the development phases preceding system testing. These include requirements traceability and software design analysis. The IV&V Team will provide advice on the implementation of new software technologies, perform process assessments, and resolve software issues as directed by FSA. During testing, the IV&V Team will monitor the developer's acceptance testing in addition to providing an independent testing assessment. Standards for IV&V tasks are described in the following sections.

Mandatory IV&V tasks are shown in Exhibit 2-2, and optional IV&V tasks are shown in Exhibit 2-3. The list in Exhibit 2-3 is illustrative and not exhaustive. Suggested applications for these

optional tasks are provided within the exhibit. Descriptions of these optional tasks are provided in Section 2.5.12. The specific IV&V procedures to implement these tasks are detailed in Section 3.

	PHASES				
TASKS BY SECTION NUMEBER	**Vision**	**Definition**	**Construction**	**System Deployment**	**Support**
2.5.11 Anomaly and Proposed Change Evaluation			•	•	•
2.5.5 Independent Testing		•	•		
2.5.10 In Process Reviews	•	•	•	•	•
2.5.6 Metrics Analysis		•	•	•	•
2.5.4 Monitor System Development and Test					
--Requirements Validation	•	•	•		
--Interface Analysis		•	•		
--Design Evaluation		•	•		
--Test Evaluation			•	•	
--Traceability Analysis		•	•		
2.5.8 Periodic Audits		•	•	•	
2.5.9 Process Assessment Activities	•	•	•	•	•
2.5.3 Product Assessment Activities	•	•	•	•	•
2.5.1 Risk Analysis	•	•	•	•	
2.5.7 Special Engineering Studies	•	•	•	•	•
2.5.2 Verify Entrance/Exit Criteria	•	•	•	•	•

MANDATORY IV&V TASKS

Exhibit 2-2

	PHASES					CONSIDERATIONS
TASKS	**Vision**	**Definition**	**Construction**	**Deployment**	**Support**	
Additional Metrics Analysis		•	•	•	•	Requirements not well-defined; changing environment
Algorithm Analysis		•	•			Numerical and scientific software using critical equations or models; regulatory compliance
Control-Flow Analysis		•	•			Complex, real-time software
Database Analysis		•	•			Large database applications; if logic is stored as parameters
Dataflow Analysis		•	•	•		Data-driven real-time systems
Feasibility Study Evaluation	•			•		High-risk software using new technology or concepts
Functional Configuration Audit			•	•		For large software developments
Independent Regression Testing		•	•	•		Large, complex systems

OPTIONAL: IV&V TASKS
Exhibit 2-3

	PHASES					CONSIDERATIONS
TASKS	**Vision**	**Definition**	**Construction**	**Deployment**	**Support**	
Installation Configuration Audit				•		Medium to large development efforts
Performance Monitoring				•	•	
Physical Configuration Audit				•		For large software developments
Simulation Analysis	•	•	•	•		No system test capability or the need to preview the concept of feasibility or the requirements for accuracy
Sizing and Timing Analysis		•	•			
Test Certification			•	•		For critical software
User Documentation Evaluation	•	•	•	•	•	Interactive software requiring user inputs

OPTIONAL: IV&V TASKS
Exhibit 2-3

	PHASES					CONSIDERATIONS
TASKS	**Vision**	**Definition**	**Construction**	**Deployment**	**Support**	
Walkthroughs						
--Requirements		•				
--Design		•	•			
--Source Code			•			

OPTIONAL: IV&V TASKS
Exhibit 2-3

2.5.1 Risk Analysis

The IV&V Team will assess the target system functions for criticality and risk. Criticality analysis will be based on the potential consequences associated with an error in or failure of the function. Risk assessment will be based on the likelihood of an error in or failure of the function. The IV&V Team will document the assessment rationale and rank both criticality and risk. The results of this analysis will be used to identify catastrophic, critical, and high-risk functions and to focus IV&V resources on the most critical aspects of the system design.

Risk management is a continuous process used to identify, quantify and monitor risks during each phase of the Solution Life Cycle. The IV&V Team will verify and validate proposed approaches to reducing technical, schedule, and cost risks. The IV&V Team also will perform continuous technical and programmatic risk analysis of FSA new projects and upgrades. At each major milestone, the IV&V Team will perform a formal risk analysis, while conducting brainstorming sessions to review and rank potential risks to the program, and highlighting those that require immediate attention. The IV&V Team also will assist in the preparation of risk mitigation plans, track progress towards abatement and assist in technical and programmatic issue resolution as tasked by the FSA Program Office. As requested, the IV&V Team will support the FSA Program Office in preparation of independent cost estimates using Constructive Cost Model (COCOMO), Revised Intermediate COCOMO (REVIC), or other analysis tools. The IV&V Team will calibrate these tools with historical data from previous upgrades combined with analyses of new requirements.

The Risk Watch List is used to track project risks and provide feedback to the developer and FSA. This formal process will:

- Identify issues that are actually project risks
- Keep all identified risks easily visible at all times rather than just those risks that are high profile at any given time
- Encourage the creation of strategies to keep risks from turning into problems
- Track the risks to determine if the risk exposure changes with time
- Track the risks to ensure they are addressed
- Provide a framework for future improvement

A sample of the Risk Watch List is provided on page B-7.

2.5.2 Verify Entrance/Exit Criteria

One of the key responsibilities of the IV&V Team will be to verify the entrance and exit criteria for each software phase or iteration, for the beginning or end of a milestone, and for In Process Reviews. One of the exit criteria for each phase requires a plan for the successive phase, and the IV&V Team will review this plan to ensure that it meets the entrance criteria for the next development phase. The IV&V Team will analyze the successive stages in the development for correctness, consistency, completeness (sufficient detail to show compliance) and accuracy. All activities must meet the Department of Education approved entrance/exit criteria before proceeding to the next activity. This activity is discussed further for each life cycle phase in Section 3.

2.5.3 Product Assessment Activities

The IV&V Team will review the target system documentation to assess the degree to which the documents meet system requirements. The IV&V Team will review phase or iteration dependent documentation using guidelines (i.e., checklists) for internal consistency, technical adequacy (e.g., requirements are unambiguous and testable), completeness, traceability to and consistency with higher level documentation, feasibility, and appropriate level of detail. As a minimum, the IV&V Team will evaluate planning, requirements, design, and test products. Optional tasks may include the review of selected code and/or user documentation.

The reviewer will be familiar with the appropriate checklists and referenced contract and standards materials before commencing the review. As the product is examined, deviations, deficiencies, and errors will be documented on a comment form (see "IV&V Reporting Standards and Procedures") and keyed to the associated quality evaluation criteria. The reviewer will prioritize comments on a scale from 1 to 8 where a value of 1 indicates a comment that requires immediate resolution and a value of 8 indicates a typographical error, spelling or minor word change. See Section 5, page 5-17 for a detailed description of the scale off priorities. See Section 3 and Appendix A for a discussion of specific phase-dependent procedures and the specific checklists to be applied.

The following paragraphs provide a definition for each of the evaluation criteria appearing in the checklists. For convenience, the explanations use the word "document" for the item being evaluated even though in some instances the item being evaluated may be something other than a document. In cases where the criteria are subjective, general guidance is provided for making the evaluation.

Adherence to Required Format and Documentation Standards. The required format for a document will be defined by FSA approved formats, developer approved formats and/or special contract-specified formats. Evaluation with respect to this criterion will consider whether: (1) all required paragraphs are included, (2) all paragraphs are in the required order, (3) each paragraph contains the required content, and (4) the product adheres to requirements regarding formatting, figure placement, and other presentation issues.

Compliance with Contractual Requirements. Contractual requirements are cited in the Statement of Work (SOW), Contract Data Requirements List (CDRL), the text of the contract, applicable higher level specifications, and standards and specifications included by reference in the contract. These sources will be used in evaluating against this criterion.

Internal Consistency. Internal consistency means that the document being evaluated does not contradict itself in either content or style. Elements of consistency are: (1) all statements must be compatible, (2) a given term must mean the same thing throughout, (3) a given item or concept must be referred to by the same name or description throughout, and (4) the level of detail and presentation style must be the same throughout.

Understandability. Understandability is a subjective, yet critical, component of quality. It means that: (1) the document is written using generally accepted rules of grammar, capitalization, punctuation, symbols, and notation, (2) non-standard terms, phrases, acronyms, and abbreviations are defined, (3) the material being presented can be interpreted in only one way, and (4) illustrations are adequately explained.

Technical Adequacy. Technical adequacy criterion covers the following: (1) Is the overall approach sound? (2) Does the information in the document violate known facts or principles? (3) Is it consistent with approaches known to be successful on other projects? (4) Is it well researched or based on proven prototypes? (5) Does the document appear well thought out? (6) Does the approach make sense both technically and practically?

Appropriate Degree of Completeness. Completeness means that all constituent parts are present and that each part is addressed in adequate detail. Because quality evaluations are in-process reviews, they look at products with varying degrees of completeness. The evaluator will judge whether the degree of completeness at a particular time is adequate. Sources for making this determination include project schedules, software development plans, statements indicating whether the document is preliminary or final, and common sense regarding the document's place in the overall development project. At every stage, all required paragraph titles should be present. Completeness of paragraph content depends upon when the required information is, or should be, known based upon the product status as discussed above.

Traceability to Indicated Documents. Traceability means that the document in question is in agreement with a predecessor to which it has a hierarchical relationship. Traceability has three elements: (1) the document in question fully implements the applicable stipulations of the predecessor document, (2) all material in the successor has its basis in the predecessor document, that is, no untraceable material has been introduced, and (3) the two documents do not contradict one another.

Consistency with Indicated Documents. Consistency between documents means that two or more documents that are not hierarchically related are free from contradictions with one another. Elements of consistency are: (1) all statements must be compatible, (2) a given term must mean the same thing in each, and (3) a given item or concept must be referred to by the same name or description in each document.

Feasibility. Feasibility is the degree to which the design stated in a document can be implemented given the state of the art, schedule and resource constraints, available tools and techniques, and other factors affecting the target system development. An additional consideration is that items that are feasible in isolation may not be feasible when taken together.

Appropriate Requirement Analysis, Design, Coding Techniques Used to Prepare Item. Industry accepted software engineering practices, the SOW, and the development agent's software development plan will establish the basis for this assessment. This evaluation criterion is directly related to other criteria (e.g., conformance with contractual requirements) and provides the basis for determining the soundness of the engineering techniques performed during the development effort.

This evaluation criterion has a direct impact upon the criteria of technical adequacy, feasibility, and resource allocation. In cases where a comment questions the appropriateness of requirements or design analysis in one of the above noted criteria, the comment will be directed to one of the three criteria categories above. Objective evidence (e.g., the results of analysis, simulation, or modeling) will be requested to support the final evaluation of the deficiency noted in the comment.

Appropriate Level of Detail. Level of detail is a subjective criterion whose evaluation is based on the intended use of the document. A document can err in either direction: a document that is supposed to provide requirements might be so detailed as to contain design data; a document that is supposed to provide detailed design might be too high-level. Review of the applicable documentation standards and of other documents of the same type will be used to determine whether the level of detail is appropriate.

Adequate Test Coverage of Requirements. This criterion applies to test planning documents. Aspects to be considered are: (1) Is every requirement addressed by at least one test? (2) Have test cases been selected for an "average" situation as well as for "boundary" situations such as minimum and maximum values? (3) Have "stress" cases been selected, such as out-of-bounds values? (4) Have meaningful combinations of inputs been selected?

Adequacy of Planned Tools, Facilities, Procedures, Methods and Resources. This criterion applies to manuals and planning documents. The evaluation will judge as to whether the planned items will be adequate to fulfill their intended purpose.

Appropriate Content for Intended Audience. Each document has an intended audience and must be evaluated according to how well it addresses the needs of that audience. A system user, for example, does not need design details; those same details are critical for software support personnel. The applicable documentation standard will provide guidance for making this decision. Within the guidance provided by the documentation standard, however, judgment as to whether the material provided is suitable for the intended audience will be made.

Testability of Requirements. A requirement is considered to be testable if an objective, feasible test can be designed to determine whether the requirement is met by the software. The requirements must be standalone and be compared against the expected results from the test. Compound requirements or vague requirements are difficult to test and should be avoided.

Consistency Between Data Definition and Data Use. This criterion applies primarily to design documents. It refers to the fact that the way in which a data element is defined should match the way that it is used in the software logic.

Adequacy of Test Descriptions/Procedures (Test Inputs, Expected Results, Evaluation Criteria). Test cases and test procedures should be sufficiently clear and specific that a person (other than the author of the test case or procedure) could execute the test and judge unambiguously whether the evaluation criteria had been satisfied.

Completeness of Testing. Testing is complete if all test cases and all test procedures have been carried out, and all results have been fully recorded, analyzed and reported.

Adequacy of Retesting. Retesting consists of repeating a subset of the test cases and test procedures after software corrections have been made to correct problems found in previous testing. Retesting is adequate if: (1) all test cases and test procedures that revealed problems in the previous testing have been repeated and the results have met acceptance criteria, and (2) a selected subset of the test cases and test procedures that revealed no problems during the previous testing, but that are needed to evaluate continued correct operation of the modified software, have been repeated and the results have met acceptance criteria. Criterion 1 is straightforward to evaluate. Criterion 2 is subjective. Complete retesting, using all test cases

and all test procedures, is not often practical. A judgment will be made as to: (1) are the selected test cases and procedures those most likely to have been affected by the software changes, and (2) are the selected test cases and procedures those whose outcome is most important? These will be the primary criteria for judging the adequacy of retesting.

2.5.4 Monitor System Development and Test

This task includes the overall assessment of the target system requirements, design and test. Specific tasks that will be performed for each of these phases are described in Section 3. The IV&V Team will perform analyses to ensure that the requirements form a solid basis for design. These analyses include requirements traceability to both the system design and test, as well as interface definition assessments. The architecture design as well as prototype efforts (e.g., Human Computer Interface) may be assessed by the IV&V Team. As an optional task, the IV&V Team may perform analysis of appropriate sections (e.g., those deemed to be "critical") of the source code to verify correct, complete and accurate implementation of the software requirements and design specifications and will assess the maintainability and reliability of the code.

The IV&V Team will analyze the developer's test program to assess complete and adequate test coverage; validity of the test definition; proper acceptance criteria; sufficient planning of tools, facilities, procedures, methods and resources; adequate planning for regression testing; and correct and complete traceability with test documents. The IV&V Team will analyze the test documentation to verify that the requirements are correctly reflected and to confirm that data and command initiation and response assumptions are consistent with the specified requirements. The IV&V Team may recommend specific changes to the developers' test plans and procedures whenever inadequacies are identified. The IV&V Team may recommend selected test scenarios to be monitored and specific test results to be independently analyzed. The IV&V Team will assess the results of formal testing of requirements and any issues or problems resulting from the verification. The IV&V Team will witness developer testing of the target system as directed by FSA. The IV&V Team will observe developer testing to confirm that the tests are conducted in accordance with approved test plans and procedures.

2.5.5 Independent Testing

The IV&V Team will perform an independent test assessment of the target system. The IV&V Team will generate the test plan, test design, test cases, and test procedures in preparation for IV&V testing. The IV&V Team will perform independent testing to validate that the system meets its critical requirements. This independent testing will complement rather than duplicate the developer's testing.

The IV&V Team will provide the results of independent testing to FSA, as well as to the developer. The IV&V Team will submit reports to the developer for any anomalies detected during independent testing. These incident reports will be entered by the developer into the developer's configuration management system to be tracked by the IV&V Team. Upon resolution of the anomaly, the IV&V Team will monitor the implementation and retesting of the fix. The IV&V Team may perform independent regression testing as an optional task (see Section 2.3.12).

2.5.6 Metrics Analysis

The IV&V Team will use software metrics to predict the target system's ability to comply with requirements and schedules. The IV&V Team will review proposed software progress and quality metrics for conformance to sound software engineering principles as well as to Department of Education reporting requirements. Some of the technical metrics may include software development and test schedule metrics, and software error reporting. Additional metrics analysis tasks are discussed in Section 2.5.12, page 2-19.

2.5.7 Special Engineering Studies

Throughout a project's development, technical and programmatic issues may arise that require further study and analysis to resolve. For each issue selected for analysis, the IV&V Team will prepare a brief plan and submit the plan to the FSA Program Manager for approval prior to initiating the analysis. In addition to proposed activities, schedule, travel requirements, estimates of effort, and impact upon other tasks (if any), each plan will include:

- The exact nature of the problem to be analyzed along with all available detail
- The goal of the special study or investigation (for example, to determine the source of the problem or to create evaluation models)
- The ground rules for conducting the special study or investigation (for example, security considerations, degree of interference with the development agent allowable, and/or roles of other agencies)
- The time frame allowed for completion of the effort

Following the completion of each analysis, the IV&V Team will submit a report to the FSA Program Manager that summarizes the analysis, findings, and conclusions and highlights any follow-up activities that are required to enable final issue resolution.

2.5.8 Periodic Audits

The IV&V Team will perform system-related process and product audits at the developer's sites throughout the system development life cycle. These process and product audits will be scheduled through the FSA QA Program Office and coordinated with the developer's schedule. The process audit will search for objective evidence that the developer is following an appropriate development plan. The product audit will concentrate on the actual software development artifacts that represent the system at that point in its development.

2.5.9 Process Assessment Activities

The IV&V Team will assess the developer's software processes using multiple criteria including statements-of-work, Department of Education standards, and the developer's plans and policies. The IV&V Team will assess the developer's process infrastructure, which may include software development plans and the establishment of a software engineering environment. The IV&V

Team will evaluate the developer's proposed use of commercial and/or custom software development/test tools.

The Capability Maturity Model (CMM) will be the standard for assessing and recommending improvements for the developer's software processes. This model is an effective means for modeling, defining, and measuring the maturity of the processes used during software development. The CMM is organized into five maturity levels:

1. Initial. The software process is characterized as ad hoc, and occasionally even chaotic. Few processes are defined, and success depends on individual effort and heroics.
2. Repeatable. Basic project management processes are established to track cost, schedule, and functionality. The necessary process discipline is in place to repeat earlier successes on projects with similar applications.
3. Defined. The software process for both management and engineering activities is documented, standardized, and integrated into a standard software process for the organization. All projects use an approved, tailored version of the organization's standard software process for developing and maintaining software.
4. Managed. Detailed measures of the software process and product quality are collected. Both the software process and products are quantitatively understood and controlled.
5. Optimizing. Continuous process improvement is enabled by quantitative feedback from the process and from piloting innovative ideas and technologies.

Predictability, effectiveness, and control of an organization's software processes are believed to improve as the organization moves up these five levels. The IV&V Team will use the CMM to identify the key practices that are required to increase the maturity of the developer's software processes. Except for Level 1, each maturity level is decomposed into several key process areas that indicate the areas an organization should focus on to improve its software process. Each key process area is described in terms of the key practices that contribute to satisfying its goals. The key practices describe the infrastructure and activities that contribute most to the effective implementation and institutionalization of the key process area.

The IV&V Team will initially focus on maturity Level 2, which addresses the software project's concerns related to establishing basic project management controls. The key process areas are Requirements Management, Software Project Planning, Software Project Tracking and Oversight, Software Subcontractor Management, Software Quality Assurance, and Software Configuration Management. Goals will be updated as each maturity level is attained.

The IV&V Team will assess the developer's configuration management organization. The IV&V Team will monitor the configuration management activities of configuration identification, configuration control, and configuration status accounting and reporting. The IV&V Team may perform configuration control audits to assess the developer's configuration control procedures and the enforcement of these procedures. If available, the IV&V Team will review the developer's formal configuration management plan. The IV&V Team will evaluate the developer's configuration management tools and methodologies.

2.5.10 In Process Reviews

In Process Reviews (IPR) will be conducted during the upgrade process to keep the community apprised of the FSA program development status. FSA (and perhaps other Department of

Education organizations), the developers, and the IV&V Team participate in these meetings. The IV&V Team will review the FSA-defined entrance and exit criteria for these reviews to insure that all goals are met and that the developer can proceed with the next phase of development. These reviews may be in the form of IPT meetings, System Requirements Reviews, Design Reviews, or Readiness Reviews. The IV&V Team will provide the results of applicable IV&V tasks to support these reviews. In addition, as directed by FSA, the IV&V Team will support Post Implementation Reviews to assess the operation and maintenance of the target system as well as evaluate the "Lessons Learned" as a result of the overall development.

2.5.11 Anomaly and Proposed Change Evaluation

The IV&V Team will monitor the status of target system anomalies (also known as incidents) and deficiencies to assure the validity of any resultant changes. The IV&V Team will monitor anomalies detected during both developer and independent testing. These will be tracked and trend analyses may be performed to determine the number of test-related problems. If requested by FSA, the IV&V Team will review any software defects discovered (or outstanding) after completion of target system testing. The IV&V Team may review corrective actions, verify priorities and confirm the disposition of the change. The IV&V Team may perform detailed reviews of the anomalies to help verify the correct disposition of system problems. If tasked by FSA, the IV&V Team will participate in the regression testing of the fixes. In addition, the IV&V Team will support Configuration Control Boards (CCB) if requested by FSA and provide inputs as needed.

The IV&V Team may also review proposed change candidates initiated when a revision to the baseline requirements is necessary to enhance or improve the program's function. If tasked by FSA, the IV&V Team will participate in functional working groups to define system and software upgrade requirements. For this optional task, the IV&V Team will perform requirements analysis including the development of engineering white papers, desktop analyses, and coordination of community inputs. The IV&V Team will review these proposed requirements for feasibility, accuracy, and completeness, while assessing the impact on the operational system.

As part of the anomaly and proposed change assessment, the IV&V Team will perform some or all of the following:

- Perform independent impact assessments concerning the expected operational environment, affected interfaces, feasibility, technical approach, and testability
- Provide evaluation of risks
- Conduct independent reviews of proposed changes as required
- Perform traceability analyses to ensure that all affected documents accurately, correctly, and consistently reflect the approved changes
- Conduct an independent review of the resulting design

- Monitor the implementation progress and review code to detect development problems and/or unapproved deviations

- Monitor regression testing to validate incorporated system changes

2.5.12 Optional IV&V Tasks

Optional IV&V Tasks will be performed at the discretion of the IV&V Team. By selecting from these optional IV&V tasks, the IV&V Team can tailor the IV&V effort to FSA needs and also achieve a more effective IV&V effort.

Additional Metrics Analysis. The IV&V Team will prepare a metrics analysis report for FSA which summarizes the developer's metrics, presents the results of the IV&V Team analysis (both objective and subjective), and provides conclusions and recommendations to FSA. For example, the developer's metrics report may include raw data such as development status, object integration status, system test status, test anomaly status, SLOC count, simulation status, staffing, and development schedule. The IV&V Team will assess the developer's progress to date, progress since last period, progress versus planned, work units remaining, and ratio of incremental accomplishment to that required to complete on schedule. The IV&V Team will retain the original plans for schedule, rate of accomplishment, and original SLOC estimates so that current status may be measured against planned status.

Algorithm Analysis. The IV&V Team will confirm that selected algorithms are correct, appropriate, and stable, and meet all accuracy, timing and sizing requirements.

Control Flow Analysis. The IV&V Team will confirm that the proposed control flow is free of problems, such as design or code elements that are unreachable or incorrect.

Database Analysis. The IV&V Team will confirm that the database structure and access methods are compatible with the logical design.

Data Flow Analysis. The IV&V Team will confirm that the input and output data and their formats are properly defined, and that the data flows are correct.

Feasibility Study Evaluation. The IV&V Team will evaluate feasibility studies performed during the Concept Design for correctness, completeness, consistency, and accuracy. The IV&V Team will trace back to the statement of need for the user requirements. Where appropriate, the IV&V Team will conduct an independent feasibility study as part of the IV&V tasks.

Functional Configuration Audit. Prior to delivery, the IV&V Team will assess the performance of the software relative to the requirements specified in the software requirements specifications.

Independent Regression Testing. The IV&V Team will independently determine the extent of IV&V analysis and independent testing that should be repeated when changes are made to any software products previously examined.

Installation Configuration Audit. The IV&V Team will perform an installation configuration audit to assess the operations with site dependencies and the adequacy of the installation procedure.

Performance Monitoring. The IV&V Team will collect information on the performance of the software under operational conditions. The IV&V Team will determine whether system and software performance requirements are satisfied.

Physical Configuration Audit. The IV&V Team will assess the internal consistency of the software, its documentation, and its readiness for delivery.

Simulation Analysis. The IV&V Team will simulate critical aspects of the software or system environment to analyze logical or performance characteristics that would not be practical to analyze manually.

Sizing and Timing Analysis. The IV&V Team will obtain program sizing and execution timing information to determine whether the total of the allocated budgets is within the overall allocation for the item. Analyses should include network resources (bandwidth, servers, etc.). More subtle assessments include: (1) Do the allocations seem realistic and feasible? (2) Do they take into account the demands on each computing unit or component, or do they seem to be more mechanical allocations, such as dividing available storage by number of computing units? (3) Are they based on prototyping and other analysis, or just on guesswork? (4) Are they worst case? (5) Do they allow for the reserve requirements?

Test Certification. The IV&V Team will confirm that reported test results are the actual findings of the tests. Test related tools, media, and documentation will be certified to confirm maintainability and repeatability of tests. This may be performed informally or as part of the optional Functional Configuration Audit (FCA).

User Documentation Evaluation. The IV&V Team will examine draft documents during the development process to confirm correctness, understandability, and completeness. Documentation may include user manuals or guides, as appropriate for the project.

Walkthrough. The IV&V Team will participate in the evaluation processes in which development personnel lead others through a structured examination of a product. The IV&V Team will assess the developer's review process, product checklists, defined roles of participants, and forms and reports. The IV&V Team will observe if the walkthrough process is well-structured, and if issues and action items are recorded and progress monitored. The specific types of walkthroughs that the IV&V Team may assess include requirements walkthroughs, walkthroughs of the preliminary design and updates of the design, and source code walkthroughs.

2.6 IV&V Tools

To perform effective IV&V, the IV&V Team will employ an integrated IV&V toolset that may include requirements, design and code analysis, test, and metrics tools. The tools objective is to enable more efficient and accurate verification and validation of design, code, and test documentation. However, it must be recognized that tools do not replace analysis by qualified engineers. The team will select tools based on established IV&V program goals, organizational compatibility, tool effectiveness, solution constraints, cost, acquisition time requirements, and training requirements. Commercial-off-the-shelf (COTS) tools will be selected wherever possible. If required to support IV&V analyses, the IV&V Team will develop automated tools or

modify existing ones through custom programming solutions at the direction of the FSA Program Manager.

2.6.1 CASE Tools

Computer Aided Software Engineering (CASE) tools provide the software developer with a complete set of visual modeling tools for development of software in the client/server, distributed enterprise and real-time systems environments. If access is provided, the IV&V Team will use these design tools to perform on-site audits of Software Development Files (SDF) or Application folders and perform technical analysis of design information. When the IV&V Team is not on-site at the developer's facility, the IV&V Team will review the design reports, models and output from the CASE tool.

2.6.2 Requirements Management Tools

When off-site at the IV&V Team's offices, the IV&V Team will request (or require) regular snapshots of the requirements database to perform various traceability tasks. In addition, the IV&V Team may use additional tools to import some of the requirements data to perform various audits and traceability activities.

2.6.3 Configuration Management Tools

The IV&V Team will analyze the developer's configuration management tool suite to verify that requirements and source code are under configuration control. The developer may use several configuration management tools as appropriate to its various software development environments; however, it is strongly recommended that the developer implement a standard tool for consistency. The IV&V Team will confirm that each tool provides an environment wherein all change management is handled consistently. This promotes uniformity across the team and minimizes errors.

2.6.4 Test Tools

The IV&V Team will examine the developer's test tools (e.g., test generation tools) used for unit, integration and performance testing. Acceptance Testing for some of the target systems may be performed using automated test scripts to exercise the system. The IV&V Team will verify the correct execution of these scripts during testing and will verify the test outputs from these tools.

2.6.5 Model Verification and Analysis Tools

The IV&V Team may review, verify and validate computerized system and performance models if available. Models will be evaluated for viability of approach to satisfying requirements and validated for consistency with the system architecture, concept of operations and evolving designs. At a minimum, modeling techniques, methodologies, tools and checklists will be documented and expected results will be verified. The IV&V Team will review these models and verify their feasibility and correctness.

The IV&V Team will have software life cycle cost estimation tools to analyze and validate the software sizing and cost estimates provided by the developer. The IV&V Team may also use

tools and various compilers to analyze the source code and verify Source Lines of Code (SLOC) estimates. Specific tools will be selected and documented as required.

2.7 IV&V Engagement and Tailoring Strategies

FSA target systems cover a broad range of disciplines, staff sizes, types of efforts, developments, and duration. Therefore, the IV&V life cycle analysis tasks must be tailored to match the tools and unique processes inherent in the applicable methodology and development environment. The specific IV&V tasks detailed in these standards and procedures are in accordance with the applicable software development life cycle phases described in the SLC. Section 3 of these standards and procedures addresses each of these phases in detail. Throughout the development life cycle phases, the IV&V Team conducts IV&V of all system modifications, enhancements, additions, and approved changes.

The IV&V plan for a specific project should be tailored for the development environment that has been chosen. The major factors to be considered are life cycle methodology, traditional versus accelerated development, centralized versus Internet development environment, and externally imposed constraints. It must be kept in mind that key development issues such as requirements always remain important; the only differences may be in the timing and methods used, not whether or not they will be evaluated in depth.

2.7.1 Life cycles

A life cycle model is a plan that outlines the way in which a project is to perform the activities central to that project. A software methodology is a more detailed expression of this plan that follows certain established software engineering principles. It also establishes the criteria used to determine if it is appropriate to proceed from one task to another. The FSA Solution Life Cycle Process Guide does not specify the particular methodology to be used but allows the developer to use one that is appropriate to the project as long as it satisfies the guidelines of the SLC. The following section outlines the IV&V strategies appropriate to specific methodologies. These should be considered as a general guide only, since it is impossible to authoritatively state that one method will always be better than others. The differences between the methods are often not as clear as the descriptions make them appear, as developers and managers may mix these approaches at some levels. These matrices highlight those IV&V functions that should receive particular emphasis, but it should be noted that all IV&V functions remain important, and none should be neglected.

2.7.1.1 Waterfall

In this model, the oldest and still one of most commonly used, the project proceeds through a series of separate sequential steps starting with the concept and ending with implementation. There is usually a review at the end of each step to determine if it is acceptable to proceed to the next step. If it is found that the project is not ready to proceed, the project is held in the current step until it is ready. In the pure form of this methodology, the different steps do not overlap.

Characteristics	IV&V Response
Well-defined, sequential stages characterized by clear entry/exit criteria.	Conduct review of entry/exit criteria at boundary between stages and ensure that stage is finished.

Characteristics	IV&V Response
Requires clear and complete documentation for each stage.	Ensure that documentation is clear and complete at exit from each stage.
Development team should be very familiar with technical methodologies used.	Ascertain in Vision Phase that team is experienced in tools selected for project.
Requires knowledgeable users with in-depth knowledge of system and a commitment to provide developer with support to define requirements.	Ensure that developer identifies key customers and conducts in-depth sessions to define requirements. Ascertain if developer is receiving required support from key customers with appropriate knowledge.
Requires detailed definition of requirements prior to Construction Phase.	Ensure that requirements are sufficiently detailed before exit from Definition Phase.
Software delivered at the end of the project, so progress may not be clear.	Closely monitor the Project Work Plan and ensure that any project slippage is reported.

2.7.1.2 Modified Waterfalls

There are different versions of this method but they may approach the problem by modifying the traditional "pure" waterfall approach by allowing the steps to overlap, reducing the documentation, and allowing more regression. Some of the more useful versions are:

Overlapping Waterfall
The development stages overlap allowing discovery and insight in later stages; i.e. the requirements analysis may still be occurring partway into the Detailed Design stage. This mirrors many real-life projects.

Characteristics	IV&V Response
Documentation may be reduced during intermediate stages if continuity of personnel is maintained.	If personnel turnover becomes high or key personnel leave, IV&V shall review documentation and highlight areas of uncertainty.
Requirements will probably not be completely defined until the Build portion of the Construction Phase.	Monitor Requirements Traceability Matrix closely to identify open requirements, partially defined requirements, and requirements not defined to appropriate level of detail. If they are not addressed at a determined point in the Construction Phase, identify them as high risk issues.
Requirements may change late in cycle.	Ensure that changes are tracked through CM process and that all affected code is regression tested. This may include sections of code not changed but interacting with changed code.
Milestones are more ambiguous because the clear boundary between stages is no longer available.	Review Project Work Plan for clear points at which progress can be checked. Monitor checkpoints and quickly report slippage from

Characteristics	IV&V Response
	these points.
Activities being performed in parallel can lead to miscommunication, mistaken assumptions, and inefficiency.	Review documentation, attend meetings, review meeting notes, email and other communication means, and note any areas of confusion. Alert developer and work with development team to identify areas where communication problems are increasing.

Waterfall with Subprojects
The architecture is broken into logically independent subsystems that can be done separately and integrated together later in the project. This allows each subproject to proceed at its own pace rather than having to wait for all subprojects to have reached the same stage of readiness before proceeding to the next stage.

Characteristics	IV&V Response
Architecture is broken into logically independent subsystems that can be done separately and integrated together later in the project.	Closely review subsystem definition, looking for unidentified interdependencies between subsystems.
Subsystems are integrated late in project.	Closely monitor testing after integration to ensure that relationships between subsystems are thoroughly tested.

Waterfall with Risk Reduction
A risk reduction spiral (see Spiral Development below) is introduced at the requirements stage and/or the architectural stage.

Characteristics	IV&V Response
Do not have to fully understand requirements before beginning architectural design.	Ensure that a thorough review of deliverables is done at the end of each spiral iteration and that they are correct for the objectives defined at the beginning of the spiral.
Complicates management of project.	Ensure project management is closely monitoring project issues and tracking risks. Ensure mitigating strategies are identified for project risks.

2.7.1.3 Prototyping

The system concept is developed as the development team moves through the project by developing and demonstrating part of the system, usually the most visible part, to the customer. Modifications may be made and the next part is then developed based on feedback from the customer. At some point, agreement is reached between the customer and the developer that the prototype is satisfactory and outstanding work is finished and the system delivered.

Characteristics	IV&V Response
Software is demonstrated to customer as it is developed and modified according to customer feedback.	Monitor for signs that project scope is growing out of bounds. There should be clear agreement at the end of each prototyping session that the system is evolving rather than simply growing. Modifications should be clearly identified and accepted by both developer and customer.
Scope of project will not be well known at beginning.	Track requirements to verify that they are being refined. If new requirements are identified, examine them to see if they will fit within the time and budget constraints of the project.
Requirements may change rapidly.	Monitor for signs that methodology is not slipping into “code and fix” mentality.

2.7.1.4 Spiral

This is a risk-oriented method that breaks a project into smaller "mini-projects." Each mini-project focuses on one or more identified major risks in a series of iterations until all risks have been addressed. Once all the risks have been addressed, the spiral model terminates the same way the waterfall model does.

Characteristics	IV&V Response
Good model for many RAD projects.	In Vision Phase, examine in terms of specific project needs and point out alternative methodologies if applicable.
Complicated and requires sophisticated, experienced management and personnel.	In Vision Phase, ensure that development team has experience in, and understanding of, the methodology.
Iterative, risk-oriented model.	Make certain iterations start on a small scale and build in importance. Ensure objectives, risks, and deliverables are all clearly identified in each iteration. Ensure risk-model is not used as an excuse for skipping the iteration, or iterations, necessary to establish clear requirements. Thoroughly examine iteration artifacts at the end of each iteration for indications that risks cannot be dealt with satisfactorily.

2.7.1.5 Staged Delivery

This bears some similarities to both Prototyping and Waterfall with Subprojects in that software is demonstrated and delivered to the customer in successive stages. The steps up to and through architectural design are the same as the Traditional Waterfall, and the following build and deliver steps are done for each of the separate stages. It differs from Prototyping in that the scope is

established at the beginning of the project and the software is delivered in stages rather than in one package at the end as is done with the waterfall method. It differs from Waterfall with Subprojects in that the stages are delivered independently rather than integrated towards the end of the project.

Characteristics	IV&V Response
Requires careful planning from both managers and technical leads.	Review stage definitions and justification carefully to verify that chosen breakdown is credible.
Interdependencies between stages must be understood.	Review stages for unidentified interdependencies. Make sure that all stages are tested as a system after delivery of the final stage.
Customers receive useful stages before the end of the project.	Review stages as they are delivered to verify that they meet user needs and are acceptable to the customer.

2.7.1.6 Hybrid Approaches

These methodologies may be combined, e.g., a risk spiral combined with a modified waterfall, or prototyping with waterfall or spiral. However, care should be taken that this is done for the purpose of improving the development process for a particular project, not for reasons of expedience. For instance, spiral development should not be chosen under the assumption that it lessens the need for the development of requirements. The Spiral methodology differs in the manner in which and the stage at which the requirements are determined, not whether or not the requirements are specified and documented. The tailored IV&V response to a Hybrid methodology will depend on which methodologies are used.

2.7.1.7 COTS

These are commercial software products developed to meet certain needs. These packages vary considerably in complexity and cost depending on the needs they are designed to meet. The nature of these products does not reduce the requirement for IV&V because they still must be integrated with other components of the target systems.

Characteristics	IV&V Response
Will rarely satisfy all needs, especially for large, complex systems.	In Vision Phase, carefully review capabilities of proposed software to verify that it meets minimal needs.
Immediate availability (immediacy varies depending on amount of tailoring necessary).	Determine if timetable necessary to install package will negate time gained by purchasing commercial software. Confirm by examining the experience of similar organizations.
Can be revised to meet custom needs.	Examine software capabilities in light of customer expectations to determine degree of realistic customization compared to probable customer needs for future change.

2.7.2 Rapid Application Development

Rapid Application Development (RAD) is a term often used without being clearly defined. It may mean rapid prototyping to one user, the use of CASE tools and tight deadlines to another, or a headline article in a trade journal to a third. As a useful term in a strategic sense, the best usable definition is that RAD means a project that requires an accelerated development environment compared to more traditional project modes and timelines. It requires more careful management and better understanding of the risks involved. Using this definition frees RAD of association with any one set of tools and focuses on the relationship between software development methods within specific environments especially in relation to time constraints.

There are no hard and fast rules regarding which methodology is best for RAD. There are some projects that can be developed more rapidly by a team coding in COBOL than by a team using an Object Oriented Development (OOD) approach because the OOD team may have to spend significant time defining and developing the underlying classes. Which approach to take in this example might hinge on risk factors comparing time constraints to the value of future code reuse in the given environment. The same factors affect the IV&V approach taken. See Exhibit 2-4 for a comparison of full IV&V with externally constrained IV&V and RAD IV&V.

2.7.3 Development Environments

IV&V needs to consider the differences between the traditional development architectures of mainframe, desktop, and client-server compared to the newer environment represented by the Internet, specifically Web-enabled applications with a large, diverse, distributed user community. The Web has given organizations unparalleled means of providing easy access to constituencies. At the same time it has introduced perspectives and problems that were not evident in the preceding technologies. The main areas of concern for IV&V in a Web environment may be categorized as:

- User base may be very large and poorly defined compared to that of a traditional system
- Wide variation in client hardware and software
- Privacy issues
- Accessibility issues as expressed in Section 508 assume even greater importance
- Usability issues
- Site navigation
- Security
- Performance issues due to larger user base and the use of images
- The graphical interface presents a public face
- Availability issues in terms of users being accustomed to 24/7 access; frustration now that perceived slow response is measured in seconds, not days or hours
- More interactive (e-mail notifications and responses)
- Online forms
- Downloadable documents
- Search engines

For these reasons, it is critically important that all Web development must meet Department standards for Web development.

2.7.4 Externally Imposed Constraints

For best results IV&V should always begin as early as possible in the SLC and be performed as described in this Handbook throughout the cycle. However, there are times when an abbreviated IV&V must be performed due to external constraints. IV&V efforts may be tailored for these circumstances, but it must be remembered that the level of project risk will rise substantially as the level of IV&V effort is reduced. The two most common reasons for such constraints and the corresponding tailoring strategies are described in the following two sections.

Regardless of the limitations imposed by these situations, the IV&V Team requires timely access to developer documentation, status information, requirements, configuration management (CM) data, test results, and anomaly data. The IV&V Team requires visibility into the development and test effort as early as possible. Access must be complete, but the effort of the IV&V Team from the point of involvement will be determined by the type of external constraint. The IV&V Team must still be exposed to all aspects of the development effort in order to perform an adequate and accurate assessment. The cooperation of the developer will become even more important in developing a good working relationship with the IV&V Team. Exhibit 2-4 compares the IV&V activities performed across three levels of effort: full IV&V, externally constrained IV&V (including constraints due to budget and delayed start of project), and Rapid Application Development (RAD).

2.7.4.1 Budgetary Constraints

Tailoring of IV&V due to budget constraints dictates that the approach to IV&V be a targeted one, with particular emphasis placed on establishing a benchmark set of requirements and processes early in the life cycle to help transition to the scaled down effort of a targeted monitoring role. Risk management will be used to target the IV&V approach to those areas of greatest risk. The responsibility of the developer in producing good requirements will be increased because of the limitations on IV&V involvement.

IV&V resources will be focused on specific development activities and products that pose the highest risk to successful completion of the target system. The IV&V Plan should be tailored to utilize the limited budget for specific IV&V activities that mitigate risk on critical, high-risk development activities. Sampling of requirements and artifacts may be used but should be based on the risk assessment.

2.7.4.2 Delayed IV&V

Delayed IV&V refers to the assignment of the IV&V Team after the beginning of the SLC. Tailoring of IV&V due to delayed entry will be based on the point at which the IV&V Team enters the project. A risk assessment should be done immediately, with attention focused on the specific development activities and products that pose the highest risk to successful completion of the target system. The Requirements Traceability Matrix (RTM) will have to be developed primarily by the developer, and any independent tracing of requirements by the IV&V Team will be based on sampling determined by the risk assessment. The IV&V Plan will focus on testing based on major requirements and on identifying risks for PRR. Late entry of IV&V is usually a sign of concern about the project and should not be considered as a means of saving a project. At

best in this situation, IV&V can provide independent information on the risks of proceeding with the project and offer strategies for mitigating those risks.

Comparison of Full IV&V to RAD IV&V and Externally Constrained IV&V

Tailored Activities	Full IV&V	Exter Const IV&V Budg
Develop and maintain tailored FMS IV IV&V/QA Plan.	✓	Upda
Provide Weekly Status Report and issues tracking log.	✓	✓
Verify Entrance/Exit Criteria for all reviews, e.g., TRR.	✓	✓
Support Pre-Production Readiness Review (PRR) and prepare recommendation for PRR.	✓	✓
Risk analysis including preparation and maintenance of Risk Watch List.	✓	✓
Monitor Project Work Plan and track schedule slippage.	✓	✓
Requirements review for testability and correctness.	✓	Samp
Review Technical Products for correctness and maintainability.	✓	
Monitor Test Activities to verify adherence to process.	✓	✓
Review all test scripts, results and artifacts for completeness and accuracy.	✓	✓
Prepare final end of phase reports (compilation) with lessons learned.	✓	✓
Review project plan for compliance.	✓	✓
Requirements Traceability through design and test documentation to verify design and to ensure testing of correct requirements. Deliver formal Requirements Traceability Matrix.	✓	Samp
Process Compliance Audits (CM, Rational etc)	✓	Samp
Perform targeted independent testing of critical or high defect areas of system as appropriate.	✓	✓

Update: Refers to periodic update of the specified product rather than continuous maintenance.
Sampling: Refers to selection and monitoring of a subset of the specified product that is believed to represent the entire set.

Exhibit 2-4

3. INDEPENDENT VERIFICATION AND VALIDATION PROCEDURES

3.1 Management of IV&V

The IV&V Team will perform IV&V procedures in parallel with software development. Each IV&V life cycle phase ends when the IV&V tasks of that phase are completed and the software development products are determined to be adequate. IV&V life cycle phases may overlap as activities of the new life cycle phase are beginning and activities of the previous one are nearing completion. In addition, some IV&V tasks are iterative; as changes are made to the software product, selected IV&V tasks from the previous life cycle phases will be performed again, or additional IV&V tasks will be performed to address the changes. The complexity and scope of changes determine the level of detail covered by the iteration.

Life cycle Verification and Validation includes technical procedures to verify that the products and processes of each phase of the life cycle meet the requirements imposed by the previous phase, and to validate that the developed product complies with the original target system requirements. Section Three provides the procedures for the IV&V tasks to be performed throughout the development lifecycle. The FSA development work breakdown structure consists of IV&V Team activities, procedures and deliverables. Exhibit 3-1 provides a diagram of the life cycle and depicts the informal and formal processes and techniques employed for each stage of development. The recommended IV&V activities, which are required by the IV&V standard for each development phase, are shown in this exhibit. As discussed in Section 2, multiple methodologies may be used in the development of the FSA systems. While this plan addresses tasks used in all of the applicable methods, the IV&V Team will address each task in the context of the methodology outlined by the Solution Life Cycle. The following procedures are mature and follow the standards described in Section 2. They include the mandatory as well as the optional IV&V procedures and tasks. All referenced checklists are included in Appendix A, and referenced reporting templates are in Appendix C.

3.1.1 Independent Verification and Validation Plan Generation

The IV&V Team will generate an IV&V Plan for all life cycle processes. This plan will be structured based on the life cycle phases and methodology of the SLC and will include a listing of key activities and deliverables. In addition, any unique aspects of the IV&V effort will be addressed along with any specific tailoring required. This plan will be reevaluated at the conclusion of the IV&V effort for process improvement and for any updates required to this plan to perform IV&V on updates to the operational system based on lessons learned. A template for this report is included in Section 5.

3.1.2 Baseline Change Assessment

The IV&V Team will evaluate proposed software changes (anomaly and requirement changes) for effects on current and previously completed IV&V tasks. IV&V provides a unique perspective, as the IV&V Team must take a system view rather than a segment or element view of the system. As the IV&V teams reviews all of the documentation and attends meetings across

organizations, IV&V is able to monitor and trace the impact of changes and dependencies throughout the development effort. At times, IV&V is the only party performing analysis from a system perspective. Because of this unique view, it is imperative that IV&V review changes based on the entire development picture rather than just the current phase or "hot topic." IV&V must also assess the impact of these changes and provide an assessment of the impact from both an operational and maintenance perspective. In addition, the IV&V team must ensure that the changes are reflected in updates to both current and previous phase documentation for consistency, correctness and maintenance purposes. The team will also participate in key reviews of these changes and make recommendations as appropriate.

3.1.3 Management and Technical Review Support

During key milestone activities, the IV&V Team will verify entrance and exit criteria and gather supporting evidence on whether to recommend moving on to the next set of software development activities. In addition, the IV&V team must remain flexible and be ready to adapt to any unforeseen major change in scope or process of the development effort. This could result in a subsequent modification to the IV&V process as long as this change does not impact the integrity of either the IV&V or development effort.

The IV&V Team will participate in the Production Readiness Review (PRR) and will provide a final recommendation at PRR. However, the team must provide targeted feedback early in the process and work with the developer to keep the lines of communication open. IV&V must adopt a "no surprises" approach and ensure there is constant communication with the development team during all phases of development. While the input at PRR is important, issues should not surface at PRR for the first time.

3.1.4 Interface with Organizational and Supporting Processes

The IV&V Team must coordinate with other groups that are part of the development effort to ensure information sharing of process improvements and lessons learned. These interfaces should be documented in the IV&V plan as participation and cooperation with various groups including control boards and IPTs. The IV&V team should continue to review their processes and procedures to find innovative ways to maximize their working relationship with developers and management and continue to build a team oriented approach.

3.2 SLC Vision Phase

The Vision Phase is the initial system life cycle phase during which user needs are documented and evaluated. During this phase, the IV&V team must have a clear understanding of the issues facing FSA to ensure that the Solution Acquisition Plan (SAP) and Statement of Objectives (SOO) correctly articulate the needs of FSA. In this phase, the principal IV&V Team tasks will be to evaluate the Business Case and Business Performance Model documents to determine whether the defined solution satisfies user needs and project objectives, perform risk analysis, and analyze any limitations inherent in the recommended approach. During this phase, the IV&V Team will also support Integrated Product Team (IPT) meetings and formal reviews and verify that entrance and exit criteria are met.

INSERT EXHIBIT 3-1

3.2.1 Document Reviews

The IV&V Team will evaluate the Vision Phase documentation in terms of system performance needs, feasibility (e.g., overestimation of COTS capabilities), completeness and accuracy. For system upgrades, the IV&V Team will analyze the impact of proposed target system changes on existing architecture and interfaces. The IV&V Team will assist in balancing performance improvements (e.g., new processors) with functional enhancements that require greater resources. Documents reviewed during this phase typically include the SAP, Business Case and Performance Model, SOOs, task order, initial Quality Assurance, Configuration Management and Transition to Support Plans, feasibility studies, Work Breakdown Structure, high-level data flow diagrams, high-level business requirements and rapid development or iteration plans.

Task:	Vision Phase Document Reviews
Method:	The IV&V Team will evaluate documents to ensure that they are complete, correct, internally and externally consistent, specific and unambiguous. Documents will be reviewed to ensure that they tailor and adhere to the Document Review Checklist, both in a "quick-look" as well as a full up review. A coordinated comment package will be prepared, sent to the FSA, and an adjudication process initiated. During a typical upgrade, the IV&V Team will review multiple versions of all development documentation and submit comment packages for each. In order to resolve issues in a timely manner, critical issues or comments will be passed informally to the developer, and the IV&V team will work with the developer to resolve these issues in a timely fashion. The following document review steps will be applicable to all subsequent document reviews referenced for other life cycle phases and will not be repeated in the sections that follow. The method used to evaluate the quality of the target system products will be comprised of six steps: STEP 1: Review the program product using tailored Document Review Checklist. STEP 2: Generate applicable comments. STEP 3: Generate a preliminary technical report. This report will include an assessment of the product's quality. An internal IV&V Team comment walkthrough will be performed for additional analysis and/or critique. All critical issues or comments will be communicated and adjudicated in a timely manner. STEP 4: Deliver the comment package and preliminary technical report to the FSA client and development team.

Task:	Vision Phase Document Reviews
	STEP 5: Upon receipt of the developer's responses, evaluate the merit of those responses and meet to adjudicate any remaining issues. STEP 6: At the conclusion of the review/adjudication process, re-evaluate the product quality based upon the status of the unresolved comment responses. If the product is considered to be of unacceptable quality, provide specific recommendations to FSA to achieve acceptance. Otherwise, update the preliminary technical report to include the status of the comment responses. Verify that updates are incorporated in subsequent releases.
Inputs:	Vision Phase Documentation, Document Review Checklist
Outputs:	Completed Checklist, Findings
IV&V Standard Reference:	2.5.3

3.2.2 Risk Analysis

The IV&V Team will verify and validate proposed developer approaches to reduce developmental, technical, schedule and cost risks. The IV&V Team will evaluate the developer's proposed solution and processes. This will include verifying the adequacy of development technology and assumptions on the availability of GFE and/or COTS technologies. Appendix B provides a detailed process for performing risk analysis and also provides a template for the Risk Watch List.

Task:	Risk Analysis
Method:	Risk Management is a key component of IV&V and must be part of the full Solution Lifecycle. By using a risk-oriented approach, the IV&V Team is able to monitor the development effort and provide a targeted corrective action approach. The IV&V Team will maintain an independent risk watch and recommend mitigation strategies. The risk watch list should be delivered to the Mod Partner on a regular basis and the IV&V team should review all outstanding risks with the FSA and Development Program Managers. The more involved the program managers are in the process of risk assessment, the more likely all of the key risks will be identified. The IV&V Team will conduct brainstorming risk analysis sessions to review potential risks. The IV&V Team will rank these risks and compare them to the program risk assessment. This independent risk analysis will help ensure that risks will be identified and mitigated early in the process. The benefits of formalizing the risk management process will be:

Task:	Risk Analysis
	• Identify issues that are actually project risks • Keep all identified risks easily visible at all times rather than just those risks that are high profile at any one time • Encourage the creation of strategies to keep risks from turning into problems • Track the risks to determine if the risk exposure changes with time • Track the risks to verify that they are addressed • Provide a framework for future improvement
Inputs:	Current Plans, WBS, GFE and/or COTS Technologies Documentation, SAP, Business Case
Outputs:	Risk Watch List
IV&V Standard Reference:	**2.5.1**

3.2.3 In Process Reviews and IPT Support

In Process Reviews may be conducted during this phase of development. The type of reviews may include a formal walkthrough of the SAP or Business Case. The Vision Phase provides a unique opportunity for identification of discrepancies when a change of course will have the least impact. The IV&V Team will support formal walkthroughs of the SAP, the Business Case, and other formal reviews during this phase. Thorough, independent analyses will be performed and Vision Phase entrance and exit criteria verified to minimize any risk to the program. In addition, the IV&V Team will support the IPT and attend all IPT reviews as scheduled.

Task:	In Process Reviews and IPT Support
Method:	The IV&V Team will generate a checklist for entrance/exit criteria verification and will verify that all items are satisfied. The IV&V Team will also verify that action items are documented and tracked. Vision Phase Review Criteria as defined by the SLC will include, as a minimum, the following: • First Iteration of SAP and Business Case has been approved and agreed upon by stakeholder, including sponsors and advisors • Task Order reviewed, approved and awarded • Successful formation of IPT • WBS has been approved and base-lined • High Level requirements developed and approved • SLC Security Vision Checklist completed and verified • Security Assignment letters approved

Task:	In Process Reviews and IPT Support
Inputs:	Entrance Criteria, Exit Criteria, Tailored Criteria Checklist
Outputs:	Completed Checklist, Findings
IV&V Standard Reference**:**	**2.5.2, 2.5.10**

3.2.4 Process Audits

The IV&V Team will perform an audit of the developer's software processes throughout the lifecycle, with particular emphasis during the early phases. Process audits will be discussed exclusively in this phase to avoid redundancy. These assessments will be performed using multiple criteria including task orders, government and developer plans and required standards. The IV&V Team will also evaluate the developer's proposed use of commercial and custom software development/test tools. Some methodologies may include an iterative process that relies on the re-enactment of the "same" defined process over a number of iterations. This repetitive nature of process enactment, and the assessment of status metrics and lessons learned at each phase and iteration, provide an opportunity for fine-tuning the process for each successive iteration. As configuration management practices are key to a successful development effort, this process will be audited by the IV&V Team during the Vision and Definition Phases to ensure that a robust process is in place.

Task:	Process Audits
Method:	Process audits will be scheduled through FSA and coordinated with the developer's schedule and will be structured to minimize any impact to the development team. The IV&V Team will prepare an audit plan that identifies the processes to be audited, dates, points of contact, audit activities, and methods for performing the audit. The process audit will search for objective evidence that the developer is actually following established plans and that all relevant practices are carried out. The process will be evaluated against the established plans and where appropriate, source documents will be traced through the process and the results will be evaluated. The audit plan will be approved by the FSA in advance. Checklists will be prepared based on the developer's established plans. The process audit will concentrate on the actual software development processes and artifacts that represent the target system at that point in its development.
Inputs:	**Approved Audit Plan, Process Audit (CM) Sample Checklist, appropriate process plans, e.g., CM Plan, etc.**
Outputs:	Completed Checklist, Audit Report
IV&V Standard Reference:	**2.5.9**

3.2.5 Feasibility Analysis

A specification is feasible to the extent that the life cycle benefits of the specified system exceed its life cycle costs. Feasibility analysis includes verifying that a system can be developed that satisfies the requirements. The IV&V Team may perform cost benefit analysis at the option of FSA, analyze schedules and review Vision documentation to assist the FSA in determining the feasibility of upgrades and enhancements.

Task:	**Feasibility Analysis**
Method:	The IV&V Team will review results of feasibility analyses or perform independent feasibility assessments of new developments and corresponding schedules. The IV&V Team will analyze the documentation and requirements against the proposed schedule. The IV&V Team will formulate independent estimates of time for completion based on concept and high-level requirements. All options will be reviewed via team brainstorming sessions and weighted. In addition, during rapid development projects where the data is available early, Constructive Cost Model (COCOMO) analysis will be used where appropriate to validate the SLOC estimates. As a final activity, risk analysis will be performed to compare the risks of each option.
Inputs:	SAP, WBS, High-Level Business Requirements, Business Cases, and High-Level System Flow if available
Outputs:	**Feasibility Assessment Report**
IV&V Standard Reference:	**2.5.12**

3.2.6 High Level System Requirements Evaluation

Requirements traceability is a process of establishing that the needs of the users and target system are adequately stated in the documents that comprise the governing set of requirements specifications. During this phase, Business Cases are developed and high-level requirements are defined in the form of the Requirements Development and Management (RDM) Document.

Task:	**High Level System Requirements Evaluation**
Method:	The IV&V Team will review the requirements and initiate the generation of an independent Requirements Traceability Matrix (RTM) to verify requirements are in accordance with standards provided in Section 2. The requirements will be gathered by the developer during requirement review sessions and provided at a high level in the form of a Business Case. In some cases, requirements may need to be derived by the IV&V Team or gathered from documentation such as the RDM. In instances where IV&V starts late in the process or no requirements are available, Design Documentation may be used. The RTM will later be used to support the

Task:	High Level System Requirements Evaluation
	identification of requirements that do not trace to lower level documents, code, and test cases as they are delivered in each subsequent phase. The requirements will be evaluated for consistency and correctness and verified against any applicable IV&V results from the requirement derivation meetings. Any RTM must trace directly to the RDM, Business Case and Business Performance model through all phases of development.
Inputs:	Vision Phase Documentation, Developer's Business Case, Requirements Review Checklist
Outputs:	Completed Checklist, RTM, Findings
IV&V Standard Reference:	**2.5.3, 2.5.4**

3.2.7 Vision Phase Security Checklist Compliance Verification

The IV&V Team must review the results of all security reviews and will ensure that Security requirements are included as part of the Business Case. The IV&V Team should work with the assigned System Security Officer and keep him/her abreast of any IV&V security issues.

Task:	Vision Phase Security Checklist Compliance Verification
Method:	At the end of the Vision Phase, the IV&V Team will ensure that the Security Vision Phase Checklist has been completed and signed off by the Security Officer and includes the completion of all security related activities, including: • Security Requirements as reflected in the Business Case • List of Business Partners Prepared and Approved • Assignment Letters Generated • Security Artifact File System Established
Inputs:	Business Case, RTM, Assignment Letters, Business Partner List, Requirements Matrices, Completed Security Compliance Verification Checklist
Outputs:	**Findings**
IV&V Standard Reference:	**2.5.2, 2.5.10**

3.2.8 Vision Phase IV&V Metrics

The IV&V Team will internally track metrics during all phases of development and will report any concerns or issues via an MOR or as part of the Risk Watch List, Issues Log or Weekly Status Report. The method of reporting is at the discretion of the IV&V Team, depending on the

circumstances of the finding and/or the preference of the FSA Task Manager. The key to success is selecting appropriate metrics, especially metrics that provide measures over the entire software life cycle and that address both software processes and products.

Task:	Vision Phase IV&V Metrics
Method:	Metrics that are tracked must be tailored and used, or gathering them can be a wasted exercise. In choosing metrics, several factors should be considered: • The intended use of the metrics data • The usefulness and cost effectiveness of the metrics • The application's engineering installation platform • Type of development, e.g., web, COTS, OOD During this early phase, the metrics will focus on the WBS and the accuracy and correctness of the schedule. All deviations from the schedule will be tracked and significant slippage will be reported. Requirement changes will be tracked, monitored and verified. Metrics will vary from project to project, but in this early phase the emphasis will be on estimating techniques and the accuracy and consistency of the developer's planning activities.
Inputs:	Business Case, RTM, WBS
Outputs:	**Metrics MOR, or inputs to regular status reporting and risk/issue logs**
IV&V Standard Reference:	**2.5.6**

3.3 SLC Definition Phase

The Definition Phase is the period of time during which the Business Case Requirements are further defined into lower level requirements and a preliminary design. In this phase, the IV&V Team will continue to monitor the development effort and will trace the requirements through the preliminary design and further refine the RTM. As this phase proceeds, many of the functional and performance capabilities are further defined and documented in the developer RDM, Business Case and Performance Model which will be verified and baselined by the IV&V team. During the Definition Phase, the IV&V Team will support document reviews, requirements evaluation, preliminary design reviews, COTS evaluations and In Process Reviews.

3.3.1 Definition Phase Document Reviews

The IV&V Team's focus on the requirements documentation will be to ensure that all of the requirements documents are reviewed as early in the Solution Life cycle as possible. The IV&V Team will review the RDM to ensure that the requirements baseline is adequately captured. During this phase, the IV&V Team will also review system performance model criteria and updated business cases. The IV&V Team will review preliminary designs to ensure that they fully address and are consistent with the development effort. Each plan should be a complete

specification of the tasks required to achieve the objectives. Issues and concerns related to FSA plans will be forwarded to the responsible party. The IV&V Team will document errors and omissions and report them to FSA.

Task:	Definition Phase Document Reviews
Method:	The IV&V Team will perform system and requirements specification and design analyses to ensure that the system level requirements are sufficiently identified to enable an allocation to hardware and software requirements. The IV&V Team will review the preliminary design and draft test-planning documents to ensure that standards and conventions from Section 2 are followed and that the items from the Preliminary Design Review (PDR) Checklist are on schedule.
Inputs:	RDM, Requirements Specifications, Preliminary Design Documentation, Test Planning Documentation, PDR Checklist, IV&V RTM, Document Review Checklist
Outputs:	**Completed Checklist, Findings**
IV&V Standard Reference:	**2.5.3**

3.3.2 Lower Level Requirements and Traceability Analysis

Requirements traceability is a process of establishing that the needs of the users and target system are adequately stated in the documents that comprise the governing set of requirements specifications. This body of documents can include the System Specification, Human Computer Interface (HCI) definitions, requirement documents and interface requirements documentation.

Task:	Lower Level Requirements and Traceability Analysis
Method:	This will be an iterative process performed at each phase and for each delivery of documentation. The IV&V Team will review these requirements to ensure that the target system requirements are stated as binding (i.e., as a shall) and are testable. For any requirement that is partially or completely stated in a referenced document, the requirement will be traced to that document and reviewed to ensure that all necessary information is specified therein. The IV&V Team will later trace these requirements to the Detailed Design and Test Documentation. The RTM will also be compared to the developer RTM, and discrepancies will be resolved.
Inputs:	Requirements Phase Documentation, Developer's RDM, IV&V RTM, Requirements Review Checklist, Security requirement documents
Outputs:	Completed Checklist, RTM, Findings
IV&V Standard	**2.5.3, 2.5.4**

Task:	Lower Level Requirements and Traceability Analysis
Reference:	

3.3.3 Interface Requirements Analysis

Interface requirements analysis is the process of ensuring that all of the internal and external interfaces to the software are completely and correctly specified. Software reuse and standard commercial off-the-shelf (COTS) software components increase the importance of independent interface analysis by the IV&V Team.

Task:	Interface Requirements Analysis
Method:	The IV&V Team will verify that the protocols for transferring and receiving data across interfaces are in accordance with Section 2 standards, interface data are accurately described, and all of the interface documentation is consistent. In addition, the IV&V Team will compare a function's input data and source to the associated output data and destination, and trace this data through the interface documents.
Inputs:	Interface Documentation, Requirements Documentation, RTM, Functional Flows, Requirements Review Checklist
Outputs:	**Completed Checklist, Findings**
IV&V Standard Reference:	**2.5.3, 2.5.4**

3.3.4 COTS Products Evaluations

The IV&V Team will independently evaluate COTS products at the request of FSA.

Task:	COTS Products Evaluations
Method:	The IV&V Team will evaluate COTS tools based on requirements and fitness for purpose. The latest industry periodicals, the Internet, and discussions with vendors will be the source of data for analysis. In addition, the IV&V Team will talk to other agencies and organizations using the tool in a similar environment as FSA for lessons learned and to uncover known problems. The IV&V Team will provide FSA with recommendations and/or proposed alternatives.
Inputs:	Vendor Documentation, Reference Material
Outputs:	Findings
IV&V Standard Reference:	**2.5.3**

3.3.5 In Process Reviews and IPT Support

The Definition Phase still provides an early opportunity for identification of discrepancies when a change of course will have less impact. The IV&V Team will support all System Requirements Reviews, Preliminary Design Reviews and other formal reviews during this phase. Thorough, independent analysis will be performed and entrance and exit criteria verified to minimize risk to the program. The IV&V Team will continue to be a key participant in the IPT.

Task:	**In Process Reviews and IPT Support**
Method:	The IV&V Team will generate a tailored checklist for entrance/exit criteria verification and verify that all items are included. The IV&V Team will also verify that actions are documented and tracked. During this phase, the IV&V Team will support meetings and formal reviews such as IPT Reviews, and the Design Reviews. For the PDR, the entrance criteria will be rigorously reviewed, while the PDR Checklist provides information on types of items to be evaluated. This checklist will be tailored for the target system under development. Review Criteria as defined by the SLC will include, as a minimum, the following: • All updates to SAP, WBS, Business Case and Performance Model are approved • RDM and RTM have been baselined • Preliminary Design Document Approved • QA, CM and TTS Plans have been reviewed and approved • Configuration Item Index created • SLC Security Definition Phase Checklist completed and approved • Project risk and issues are manageable The IV&V Team will utilize a Preliminary design checklist for guidelines to entrance/exit criteria. The IV&V Team will verify that action items from all reviews are documented, tracked and resolved. Preliminary Design criteria include as a minimum: (1) Business process continues to support Value and Success measures identified in Vision Phase, and (2) All of the components necessary to support the business solution design have been identified and described in enough detail to assess complexity to build it
Inputs:	Entrance Criteria, Exit Criteria, Tailored Criteria Checklist, Requirements Review Checklist, PDR Checklist
Outputs:	Completed Checklists, Findings
IV&V Standard Reference:	**2.5.2, 2.5.3, 2.5.9, 2.5.10**

3.3.6 Process Audits including Configuration Management

As configuration management (CM) practices are key to a successful development effort, this process will be audited for the second time to ensure that a robust process remains in place. In addition, the IV&V Team will monitor all of the developer processes and look for opportunities for improvement.

Task:	**Process Audits Including CM**
Method:	Process audits will be scheduled through FSA and coordinated with the developer's schedule and will be structured to minimize any impact to the development team. The IV&V Team will prepare an audit plan that identifies the processes to be audited, dates, points of contact, audit activities, and methods for performing the audit. The process audit will search for objective evidence that the developer is actually following established plans and that all relevant practices are carried out. The process will be evaluated against the established plans and where appropriate, source documents will be traced through the process and the results will be evaluated. The audit plan will be approved by the FSA in advance. Checklists will be prepared based on the developer's established plans. The process audit will concentrate on the actual software development processes and artifacts that represent the target system at that point in its development.
Inputs:	**Approved Audit Plan, CM Checklist, Process Audit (CM) Sample Checklist, Appropriate process plan, e.g., CM Plan, etc.**
Outputs:	Completed Checklist, Audit Report
IV&V Standard Reference:	**2.5.9**

3.3.7 Risk Analysis

The IV&V Team will continue to monitor program risks and will maintain the risk watch list. The risk watch list should be delivered to the Mod Partner on a regular basis, and the IV&V team should review all outstanding risks with the FSA and Development Program Managers. The more involved the program managers are in the process of risk assessment, the more likely all of the key risks will be identified.

Task:	Risk Analysis
Method:	The IV&V Team will continue to maintain an independent risk watch and recommend mitigation strategies. The focus of the risk analysis will include documentation of requirements, level of traceability and adherence to schedule. IV&V will monitor external conflicts, dependencies and entities that may impact the effort.
Inputs:	Current Plans, WBS, RTM, RDM, SAP, Business Case, preliminary design documentation, preliminary test and security plans, performance models

Outputs:	Risk Watch List, findings
Task:	Risk Analysis
IV&V Standard Reference:	**2.5.1**

3.3.8 Preliminary Design Evaluation

A Preliminary Design Review is the formal technical review of the basic design approach. During this phase, all development and test tools that are planned for use during program development will be identified. The IV&V Team will continue risk and schedule analysis, support design walkthroughs, and preliminary design document reviews. This can include updates to the SAP, an updated risk assessment, a phase plan showing the number and contents of each iteration, draft test planning documentation, measurable evaluation criteria for assessing the results of the initial iterations, and a software architecture description (stating constraints and limitations). It is crucial that the IV&V Team perform a rigorous review of the exit criteria for the preliminary design reviews to ensure a successful design and minimize rework. The IV&V Team may also review the interface definitions, prototype efforts, and process infrastructure. As appropriate, the IV&V Team may provide alternatives to the proposed architecture for consideration by the community or may independently evaluate any proposed alternative design concepts and reconcile the results with those of the development contractor. The IV&V Team will review the target system design in preparation for the PDR. The IV&V Team will review and evaluate the design documents such as descriptions of the technical architecture, business process flows, HCI descriptions, and system screens.

Task:	**Preliminary Design Evaluation**
Method:	The IV&V Team will evaluate the developer's basic system architecture based on the Section 2 standards and the PDR checklist items. EDNET folders will also be reviewed for evidence of preliminary design activities.
Inputs:	Design Documentation, SDFs, Requirements Documentation, PDR Checklist, SDF Audit Checklist
Outputs:	Completed Checklists, Findings
IV&V Standard Reference:	**2.5.2, 2.5.4, 2.5.10, 2.5.12**

3.3.9 EDNET Software Development Folder Reviews

As development materials are documented, the developers typically establish a file structure on the Department of Education's FSA Network, also known as EDNET, to allow easy access to all development materials. These are commonly referred to as Software Development Folders, the drive designation (e.g., F Drive), or simply EDNET. For purposes of this plan we will refer to them as software development folders (SDF). It is imperative that the IV&V Team gain access to this drive as soon as it is established and become familiar with the directory structure. In

instances where the project is large and there are many nested directories, it is recommended that the IV&V team create a mapping to the drive that they can use and share with the development community. Easy and quick access to the data will expedite reviews and help ensure timely feedback to the developers.

Task:	**EDNET SDF Reviews**
Method:	During the system lifecycle, the IV&V Team will monitor the SDFs to ensure their currency and for compliance with Section 2 standards. The IV&V Team will perform a formal detailed audit of the SDFs at the midpoint and conclusion of the Detailed System Design. The reviews of the SDFs will be coordinated with the developer and timed to minimize impact on the development effort. The IV&V Team will tailor the SDF Audit Checklist and use this as the basis of the audit. For the definition Phase, the IV&V Team will review the SDFs and evaluate all of the preliminary planning documentation, design notes, algorithms, and updated requirements. In the Construction Phase, detailed design documentation will be reviewed along with any Program Design Language (PDL) and source code. Some of the software may be written in languages that use the Object Oriented Design Methodology. With an Object Oriented development effort, the IV&V Team will review the outputs of the developer's tools to support assessments of the design. The IV&V Team will continue to perform periodic reviews of the SDFs throughout the lifecycle, but it will only be included in this phase to avoid redundancy. The purpose of these reviews will be to verify that the source code is under CM control, the code is written in accordance with FSA traditional and web based coding standards, and the proper supporting documentation is present in the SDF. Supporting documentation includes design notes, allocated requirements, and unit test plans and results. In addition, peer review details, action items and any anomaly documentation should also be present within the SDFs.
Inputs:	Design Documentation, SDFs (EDNET), SDF Audit Checklist
Outputs:	Completed Checklist, Findings
IV&V Standard Reference:	**2.5.3, 2.5.4, 2.5.8, 2.5.9**

3.3.10 Definition Phase Security Checklist Compliance Verification

The IV&V Team must review the results of all security reviews and will ensure that Security requirements are traced through the Business Case, RDM and preliminary design. The IV&V Team will continue to work with the assigned System Security Officer and keep him/her abreast of any IV&V security issues.

Task:	Definition Phase Security Checklist Compliance Verification
Method:	At the end of the Definition Phase the IV&V Team will ensure that the Security Definition Phase Checklist has been completed and signed off by the Security Officer and includes the completion of all security related activities including: • System Roles and Responsibilities Defined • System Identified in terms of type (new or upgrade) and level of sensitivity • Completed Threat and Vulnerability Assessment • Completed Security Guidance Compliance Matrix • Completed Interconnected System's Security Documentation • Completed Drafts of Memoranda of Understanding and Service Level Agreements • Certification & Accreditation Project Plan (C&A Plan) • System Rules of Behavior documented • Constructed Clearance Requirements Matrix • Approved Contractor Access Request Form
Inputs:	Business Case, RTM, Assignment Letters, Business Partner List, Requirements Matrices, Completed Security Compliance Verification Checklist, security requirements
Outputs:	**Findings**
IV&V Standard Reference:	**2.5.2, 2.5.10**

3.3.11 Definition Phase Section 508 Compliance Review

This initial Section 508 Review is to determine the degree of compliance with Section 508 of the Rehabilitation Act and associated amendments of 1998. The purpose of this review is to ensure that the development team is coordinating with the appropriate contacts at the Department of Education with regard to Section 508, and that HCI requirements are in place for Section 508 compliance.

Task:	Section 508 Compliance Review
Method:	The IV&V Team will evaluate the developer's approach to Section 508 compliance and determine if the requirements have been addressed and if the development team is coordinating with the Department of Education's internal Section 508 point of contact. This is not meant to be a review of the application for compliance, as this is performed internally by

Task:	Section 508 Compliance Review
	Education. However, if requested by FSA, the IV&V agent can participate in the assessment. Section 508 compliance would address: • The main processing sites • The links interconnecting these sites • These sites' connections to the auxiliary sites as well as to the VDC
Inputs:	Section 508 Checklist, Reference Material
Outputs:	Part of Risk Watch List or MOR
IV&V Standard Reference:	**2.5.2, 2.5.3, 2.5.8**

3.3.12 Definition Phase IV&V Metrics

The IV&V Team will continue to track metrics during this phase of development and will report any concerns or issues via an MOR or as part of the Risk Watch List, Issues Log or Weekly Status Report.

Task:	Definition Phase IV&V Metrics
Method:	During this phase, the metrics will focus on the RDM and RTM and the accuracy of the schedule. All deviations from the schedule will be tracked, and significant slippage will be reported. Requirement changes will be tracked, monitored, and verified.
Inputs:	Business Case, RTM, WBS
Outputs:	**Metrics MOR, or inputs to regular status reporting and risk/issue logs**
IV&V Standard Reference:	**2.5.6**

3.4 SLC Construction Phase

The objective of the SLC Construction Phase is to develop and test a solution that meets the requirements defined in the previous phase, as well as the approved Business Case.

3.4.1 Construction Phase Document Reviews

The IV&V Team will review the detailed design documents such as the system and interface design documents, production capacity plans and the system conversion and deployment plans. In addition, this phase includes a review of test plans and procedures and updated TTS, CM and QA Plans. Security related plans that will be reviewed are the Security Plan, Disaster Recovery Plan and Continuity of Operations Plan. During this phase the source code and accompanying

documentation will also be reviewed at a high level to ensure that FSA coding standards, provided in the SLC documentation, are being followed.

Task:	Construction Phase Document Reviews
Method:	The IV&V Team will apply static and dynamic analysis techniques in reviewing technical documentation. Static analysis techniques will be used to analyze the technical content and form of the documentation and to ensure the proper form for updated documents and programming products, such as source code. Dynamic analysis techniques will be used to study the functional and computational correctness of the document and code. By using both techniques, the IV&V Team will perform a thorough analysis of the documentation, assuring correctness and testability of critical functional requirements. The IV&V Team will review the detailed design and preliminary test plans to ensure that standards and conventions from Section 2 are followed. The IV&V Team will apply a complete and thorough analysis to design specifications to analyze the technical content and form of all objects, and the functional and computational correctness of execution threads. The IV&V Team will assure correctness of critical functional properties and verify correct implementation of critical algorithms and requirements. The IV&V Team will also verify that the documents are compatible with sound software engineering principles. The IV&V Team will review test documentation to ensure that standards and convention from Section 2 are followed. The Document Review Checklist will be used to ensure consistency in the reviews and will be tailored based on the review performed. The IV&V Team will review the test documentation as well to verify completeness and correctness.
Inputs:	Detailed Design Documentation, Test Plans, Draft Conversion, Migration and Deployment Plans, CDR Checklist, Test Data, Test Descriptions and Procedures, SDFs, Source Code, Document Review Checklist, Code Review Checklist, TTS Plan, user documentation
Outputs:	Completed Checklists, Findings
IV&V Standard Reference:	**2.5.3**

3.4.2 Detailed Design Evaluation and Traceability Analysis

The IV&V Team design evaluation will verify that the environment maintains traceability among the engineering models (design models, source code and executable components) throughout the Construction Phase. As part of the design evaluation, the IV&V Team will evaluate design artifacts that will or may include design documentation data flows and entity relationship

diagrams, pseudo-code, SDFs, and internal and external interfaces. During the system lifecycle, the IV&V Team will monitor the software development folders to ensure their currency, as well as review the internal and external interfaces to verify design and implementation completeness, correctness, and sufficiency.

Task:	**Detailed Design Evaluation and Traceability Analysis**
Method:	The IV&V Team will seek to prevent design errors from being implemented into the solution and provide assurance that the design is optimized. To support the detailed design, the IV&V Team will: • Evaluate the evolving design and architecture • Evaluate the technical documentation • Verify that the developer RDM is implemented in the design • Conduct a design traceability analysis • Review the results of peer reviews • Participate in design reviews and technical interchange meetings Traceability will be performed between the software design documents and the software requirements documentation based on Section 2 standards. The requirement trace will be performed in both directions between requirements and design. The trace analysis will be performed to ensure that no requirements are omitted or implemented more than once, no extraneous design requirements exist, and a requirement addressed by more than one design element is completely and consistently satisfied. The IV&V Team will verify that the environment maintains traceability among the engineering models (design models, source code, and executable components). As part of the design evaluation, the IV&V Team will evaluate the design documentation, data flows and entity relationship diagrams, pseudo-code, sample screens, forms and reports, and internal and external interfaces. Design traceability analysis will ensure that all requirements have been allocated to the design documents and that the design documents contain only requirements that are detailed in the software requirements documents. The IV&V Team will examine each of the design documents and extract the requirements for the item to be traced. The IV&V Team will resolve any conflicts among the document requirements in accordance with the order of precedence clause within the contract and/or by obtaining guidance from FSA. When performing traceability, the IV&V Team will detect: • Requirements in the subordinate documents that do not connect to any baseline requirement • Requirements that are in the baseline document, but are not connected to the subordinate document

Task:	Detailed Design Evaluation and Traceability Analysis
	When database conversions are required, the IV&V Team will observe the process to ensure that proper CM controls are followed and may, if necessary, reevaluate the schema for normalization based on the platform. The IV&V Team may also verify the data integrity, after the conversion is complete, through query testing and statistical sampling. HCI assessments will be performed to evaluate the user interface and its fitness for the user community.
Inputs:	Design Documentation, Requirements Allocation Matrix, Requirements Database, Sample Screens, Forms and Reports, Requirements Review Checklist, Process Audit (CM) Sample Checklist
Outputs:	Completed Checklists, Findings
IV&V Standard Reference:	**2.5.3, 2.5.4, 2.5.9, 2.5.10**

3.4.3 Performance Model Evaluation

The IV&V Team may validate the developer's performance model, if applicable, and assess model reliability. This validation effort will be conducted at the level of detail necessary to evaluate processor utilization, communications, capacity, storage requirements, and peak performance.

Task:	Performance Model Evaluation
Method:	The IV&V Team will confirm that baseline products used by the modeling team are consistent with the controlled baseline documents. Wherever possible, the IV&V Team will validate the model using actual benchmark data. The IV&V Team will meet with the modeling team to discuss technical data relative to the model.
Inputs:	Baseline Documentation List, Benchmark Data (if available), Interviews
Outputs:	Findings
IV&V Standard Reference:	**2.5.3, 2.5.7, 2.5.12**

3.4.4 Peer Reviews

The IV&V Team will review the records of the developer's peer reviews and design walkthroughs on a periodic basis to assure that all pre-meeting, meeting, and post-meeting walkthrough requirements and tasks are completed. Specifically, the IV&V Team will examine the following items: relevant documentation for the item under review (for example, the PDL),

current system software standards and practices manual, minutes from the previous peer review and evidence of action item tracking and closure.

Task:	Peer Reviews
Method:	The IV&V Team will assess the degree to which design requirements are addressed during the peer reviews. The IV&V Team will also determine whether questions or problems resulting from the review are recorded as action items and assigned due dates for resolution. As a part of this process, the IV&V Team will submit its findings to assist the developer.
Inputs:	Meeting Minutes, Action Item List, Process Audit (CM) Sample Checklist
Outputs:	Completed Checklist, Findings
IV&V Standard Reference:	**2.5.9, 2.5.10, 2.5.11**

3.4.5 In Process Reviews and IPT Support

During the Detailed System Design Phase, the IV&V Team will support meetings and formal reviews such as IPT Reviews and Critical Design Review (CDR). For the major milestone reviews, the entrance criteria will be rigorously analyzed. For CDR, the CDR Checklist provides information on types of items to be evaluated. These will be tailored for the target system under development. The IV&V Team will continue to be a key participant in the IPT.

Task:	In Process Reviews and IPT Support
Method:	The IV&V Team will tailor and utilize the CDR Checklist for guidelines to entrance/exit criteria and to verify applicable items for the design review. The IV&V Team will also verify that all action items are documented, tracked and resolved. CDR Criteria as defined by the FSA IPT High-Level Process Overview will include, as a minimum, the following: • Components designed cover complete scope of project solution • Detailed design thorough and complete • Sources of data for conversion identified and mapped • Screens, forms, and reports are user-friendly • IV&V report issues are satisfactorily resolved Prior to the completion of the Construction Phase, the following exit criteria will be verified by IV&V: • Detailed Design Document has been developed and approved • RTM is updated • System Security Construction Phase Checklist has been completed

Task:	In Process Reviews and IPT Support
	and approved • A developed and tested solution has been completed and approved • Test Plans have been developed and executed with verifiable test results • PRR has been conducted and signed off • Configuration Item Index has been updated • Support Organization has been identified • All QA reviews have been conducted satisfactorily
Inputs:	**Entrance Criteria, Exit Criteria, Tailored Criteria Checklist, CDR Checklist**
Outputs:	Completed Checklists, Findings
IV&V Standard Reference:	**2.3.2, 2.3.3, 2.3.9, 2.3.10**

3.4.6 Build Solution Source Code Traceability and Evaluation

During this phase, the IV&V Team may, at the option of FSA, review the code in the SDFs. The IV&V Team will analyze a sample of the source code for traceability to the design document and conformance to developer and FSA standards. The IV&V Team will also analyze the developer's software metrics if applicable.

Task:	Build Solution Source Code Traceability and Evaluation
Method:	The IV&V Team will review any changes to the software and review a portion of the source code in regard to traceability to ensure that the design requirements are met, and for additional and/or unexpected requirements. The level of sampling will be based on schedule, scope of the IV&V effort, and number of problems found during IV&V analysis. A requirements matrix will be used and discrepancies documented via anomaly report. The developer will be notified immediately of discrepancies found within the developer's requirements matrix. The IV&V Team will perform code inspections during the code and unit testing to identify problems early. The IV&V Team will perform detailed reviews on a portion of the source code. This sampling will be based on complexity and criticality. To verify maintainability, the IV&V Team will review the included source code comments to ensure sufficient support of the maintenance process and an audit trail of the design. To verify consistency, the IV&V Team will review the source code standards and conventions established by the developer. When attending formal code reviews and inspecting code, the IV&V Team will use a customized

Task:	Build Solution Source Code Traceability and Evaluation
	checklist to evaluate the source code.
Inputs:	Software Coding Standards, Source Code, Design Documentation, SDFs, Requirements, Code Review Checklist
Outputs:	**Completed Checklist, Findings**
IV&V Standard Reference:	**2.5.3, 2.5.6, 2.5.12**

3.4.7 Build Solution Code and Logic Walkthroughs

The IV&V Team will periodically attend the developer's peer reviews and code walkthroughs to observe the review process, provide comments, and assure that all pre-meeting, meeting and post-meeting walkthrough requirements and tasks are completed. Prior to the code walkthrough, the IV&V Team may review:

- The source code
- The unit test documentation
- The standards and conventions
- The unit design review minutes
- Any unit design waivers or deviations
- The developer's walkthrough checklist (if applicable)

The walkthrough should address all requirements of the design. During the walkthrough, the IV&V Team will verify that questions or problems resulting from the walkthrough are recorded as action items with appropriate due dates for their resolution. If another code walkthrough is required because of open action items or a rejected design, this walkthrough will be scheduled following resolution of the applicable issues.

Task:	Code and Logic Walkthroughs
Method:	The IV&V Team will periodically attend code and logic walkthroughs on selected code. The IV&V Team will verify that formal code inspections are performed by the developer for delivered software according to established plans.
Inputs:	**Source Code, Meeting Minutes, Action Item List, Code Review Checklist, Process Audit (CM) Sample Checklist**
Outputs:	Completed Checklists, Findings
IV&V Standard Reference:	**2.5.3, 2.5.12**

Optional tasks to be performed by the IV&V Team (as directed by FSA) include:

- Conduct source code traceability and evaluation
- Perform source code and logic walkthroughs

This phase is concerned with system software development (i.e., coding and debugging) and unit testing. The IV&V Team will review the following artifacts: SDFs, code, technical and user documentation, unit test procedures, draft migration strategy, and deployment plan. The IV&V Team will review document updates as necessary, as well as the results of unit testing. The IV&V Team will review the draft test documentation as well to verify completeness and correctness. During this phase, the IV&V Team will assess the quality of developed program products including source code listings, draft user documentation, and draft software test procedures and descriptions.

3.4.8 Build Solution Unit Test Analysis

The IV&V Team will perform assessments of unit testing. This includes reviewing the results of unit testing and verifying that unit testing was accomplished and all defects were documented and corrected.

Task:	**Build Solution Unit Test Analysis**
Method:	The IV&V Team will verify that unit testing was performed and that information relating to the unit tests is adequately tracked in the appropriate test notebook or SDF. The criteria used by the IV&V Team to assess unit testing are included in the Testing Review/Audit Checklist. It should be tailored for each development effort.
Inputs:	**Unit Test Plans, Unit Test Results, Testing Review/Audit Checklist**
Outputs:	Completed Checklist, Findings
IV&V Standard Reference:	**2.5.3, 2.5.4**

3.4.9 Build Solution TRR Support

The IV&V team will encourage and support all Test Readiness Reviews (TRR). This includes verification of entrance and exit criteria to ensure readiness for testing. A sample TRR checklist is included in the appendix, and this can be tailored for each development effort.

Task:	**Build Solution Test Readiness Review Support**
Method:	Prior to the start of each test, the IV&V Team will support TRRs. Before beginning the TRR, the IV&V Team will verify that all of the entrance criteria have been satisfied. In addition, the IV&V Team will review the developer's Software Test Descriptions for traceability to detailed design and will evaluate unit test results. Upon completion of the TRR, the IV&V Program Manager will provide a recommendation as to whether or

Task:	Build Solution Test Readiness Review Support
	not to proceed with integration testing. The TRR Checklist includes the types of items that are typically part of the entrance criteria for a TRR. This can be tailored to match the particular FSA target system. TRR Criteria should include, as a minimum, the following: • The scope, specific assumptions, and considerations for each level of application integration testing are clearly defined • The test environment(s) model the production environments as closely as possible, including production-sized databases, production LAN configurations, office setup, and all automated and manual processes • Detailed integration test workplan exists • Severity and volume of open problems acceptable to proceed • Interfacing systems prepared to participate in integration test or acceptable work-around in place • IV&V report issues satisfactorily resolved
Inputs:	**Test Documentation, Requirements, Entrance Criteria, Exit Criteria, Tailored Criteria Checklist, TRR Checklist**
Outputs:	Completed Checklists, Recommendations Relative to Start of Testing
IV&V Standard Reference:	**2.5.2, 2.5.10**

3.4.10 Physical Test Environment

The physical test environment consists of the hardware, software, instrumentation, tools, simulators, and other support software necessary for testing the system. As part of IV&V test readiness evaluation, the physical test environment should be assessed to ensure that proper controls are in place and equipment and software are ready for test.

Task:	Evaluate Physical Test Environment
Method:	The IV&V Team will evaluate the test environment to verify that the proper controls are in place. Verification of the test environment will include witnessing the build, verifying that a clean install was accomplished, running a daily checksum and reviewing the output for accuracy, and checking that there are unbroken seals on the equipment. In addition, the IV&V Team will verify that proper CM controls are in effect, including control of test data and final procedures.
Inputs:	**Test Documentation, Control Procedures, Process Audit (CM) Sample Checklist**
Outputs:	Completed Checklist, Findings
IV&V Standard	**2.5.3, 2.5.4, 2.5.8**

Task:	Evaluate Physical Test Environment
Reference:	

3.4.11 Build Solution Test Evaluation

During the test evaluation effort, the IV&V Team will independently assess the test program. Once the solution is developed, it is the responsibility of the IPT to test the application to ensure that the test processes and products correctly and adequately demonstrate that the solution meets the defined and approved functional, technical, and quality requirements. The IV&V test evaluation process begins with a review of the developer unit testing through review of the Integration, Performance, System and Acceptance test plans, execution, and results.
The developer will verify requirements at each level of testing with the expectation of observing "increasing levels of confidence" during each subsequent test. During the Acceptance Test Phase, the IV&V Team will perform independent testing on the software. Final results of IV&V test findings will be compared to the appropriate developer test report and any discrepancies will be documented. To support FSA during the formal testing, the IV&V Team will:

- Evaluate updated test plans and procedures
- Verify the integrity of the test environment
- Monitor execution of a sampling of test procedures
- Evaluate test results
- Evaluate proposed corrective actions

Task:	Build Solution Test Evaluation
Method:	Evaluation of testing will be performed as testing progresses throughout this phase. The following tests are performed by the IPT subsequent to Unit testing and the appropriate TRR. These are based on the SLC and may be tailored by the Mod Partner. The **Integration Test Phase** is the period of time in the life cycle during which product components are integrated and the product is evaluated to determine whether target system requirements have been satisfied. The focus of this test is on how multiple components work together and the functions of the system. It will also test the user screens and system interfaces. The **System Test Phase** is the period of time in the life cycle during which the product is evaluated to determine whether functional and performance requirements have been satisfied. **Performance Testing** is meant to simulate large transaction volume and test critical response times to evaluate the performance of the system

Task:	Build Solution Test Evaluation
	during peak transaction periods. **User Acceptance Testing** tests the requirements from a user perspective. They must include a robust set of test conditions to exercise the system in order to ensure that it meets predefined acceptance criteria. **Alpha and Beta Testing** provides an opportunity for the user community to exercise and try to "break" the system. This level of testing is optional and not performed unless all previous levels of testing have been successful. During Alpha and Beta testing, the IV&V Team will participate in the testing process through the execution of test scripts and hands-on testing to verify that the system is ready for deployment. **IV&V Testing** is performed by the IV&V Team to test procedures that were high defect, complex, or critical aspects of the system. It is a targeted approach that can be performed between System Testing and Alpha and Beta testing based upon system availability and FSA discretion. The IV&V team will support all levels of formal testing. All IV&V test team participants will be thoroughly conversant with the test organization and procedures. At the conclusion of each successful TRR, the IV&V Team will ensure that test bed configurations are identified, documented, and under developer configuration control, and that CM procedures are followed for control of the entire test environment including procedures, data, test bed, and software. The IV&V Team will evaluate developer test preparation to ensure that the developer has prepared detailed test plans and test procedures, has verified and revised these documents based on dry run results, and that requirements fully trace to test procedures. For each test, the IV&V Team will monitor test activities and procedure execution, evaluate the results, and assess proposed corrective actions. The IV&V Team will document any deficiencies and omissions discovered during each test evaluation. The IV&V Team will concentrate on weaknesses discovered in the developer's internal test to ensure the adequate exercise of those functions requiring more rigorous testing. To evaluate for completeness, the IV&V Team will monitor testing to determine the extent to which requirements are tested (i.e., stressed or exercised). If a requirement is tested, but not stressed, the requirement will be flagged as being exercised. For requirements claimed to have been previously tested, the IV&V Team will request and evaluate the associated test results. In its review, the IV&V Team may document, on a requirement-by-requirement basis, the extent to which each requirement was tested by the developer, and whether or not it was adequately tested

Task:	Build Solution Test Evaluation
	This assessment will help form the foundation of the IV&V Team's assessment and targeted independent testing. For those tests that use an automated testing system, the IV&V Team will verify system adherence to the automated script used to execute and record the sequence test results. The IV&V Team witnesses will verify that the documented plans and procedures are executed properly and that the designated requirements are adequately tested. The witnesses will immediately document test anomalies and/or departures from the approved detailed test procedures to provide reference points for later test evaluation and validation. For all anomalies, tests may be rerun by the developer using the same test procedures in an attempt to replicate the anomaly. Should additional test cases or slightly modified tests be required to determine an anomaly's cause, the IV&V Team will ensure that these tests and modifications are thoroughly documented. Throughout testing, the IV&V Team will review all corrective actions and ensure that all change control procedures are implemented.
Inputs:	Test Plans Test Procedures, Use Cases, Test Results, Artifacts, CM Documentation, RTM, Security documentation
Outputs:	Findings, anomaly reports, MORs
IV&V Standard Reference:	**2.5.1, 2.5.3, 2.5.4, 2.5.6, 2.5.9, 2.5.12**

3.4.12 IV&V Test Procedure Development

During this phase, the IV&V Team will continue the preparation of the procedures and use cases for the independent test procedures.

Task:	IV&V Test Procedure Development
Method:	The IV&V Team will prepare independent test procedures and use cases. The preparation of procedures and use cases will be an iterative process that continues throughout the test phases of development. Following the monitoring of Integration Testing, the IV&V Team will revise the plan to incorporate more robust system testing for those areas of developer testing assessed as being less than adequate. Step-by-step procedures will be prepared together with expected results.
Inputs:	Developer Test Procedures and Use Cases, RTM
Outputs:	IV&V Test Procedures and Use Cases
IV&V Standard Reference:	**2.5.5**

3.4.13 Test Reporting and Results Analysis

The IV&V Team will review test results to ensure that all relevant data has been captured and verified. This analysis will include a review of applicable test data and the test results generated by the developer. Upon testing completion, the developer will submit test reports detailing the developer's software testing results. The IV&V Team will review these test reports and forward any discrepancies to FSA. In addition, the IV&V Team will prepare an independent test report documenting findings and lessons learned from the IV&V test activities

Task:	**Test Reporting and Results Analysis**
Method:	The IV&V Team will confirm that all the requirements were properly satisfied, and all test procedure annotations and problems have been correctly documented. Through test observation and an off-line analysis of extracted test data, the IV&V Team will verify each formal test conducted by the developer. Following observation of the developer's test, the IV&V Team will review the test execution reports and final test results to ensure that established test plan objectives were realized, test results were evaluated using the acceptance criteria defined in the approved test plan, and all test data conclusions are accurate and justified. In addition, the IV&V Team will analyze all tests containing deviations from the expected test results to ensure that problems associated with the deviations are documented for resolution and implementation. The IV&V Team will review the developer test reports to ensure that they adequately reflect the results of formal testing. In addition, outstanding problems will be reviewed and their severity assessed. The IV&V Team will prepare an IV&V Test Report upon completion of the entire test activity. The report will contain all of the IV&V Team's recommendations that were provided during the Acceptance TRR, IV&V test results, and an assessment of the product's readiness for deployment.
Inputs:	Test Plan, Test Procedures, Use Cases, Test Results, Anomaly Reports
Outputs:	Additional Anomaly Reports, Findings, Completed Checklist, IV&V Test Report, Developer Test Report, Document Review Checklist, Test Results
IV&V Standard Reference:	**2.3.3, 2.3.4**

3.4.14 Risk Analysis

The IV&V Team will continue to monitor program risks and will maintain a risk watch list. The risk watch list should be delivered to the Mod Partner on a regular basis, and the IV&V team should review all outstanding risks with the FSA and Development Program Managers. The more involved the program managers are in the process of risk assessment, the more likely all of the key risks will be identified. The focus of the risk analysis will be the requirements,

development and test. The ability to meet schedule and performance requirements must be evaluated. In addition, the progress of testing and security must be reviewed.

Task:	Risk Analysis
Method:	The IV&V Team will continue to maintain an independent risk watch and recommend mitigation strategies. Requirements traceability, adherence to cost and schedule, level of user involvement, performance, and security are all issues reviewed during this level of risk analysis.
Inputs:	Design Documentation, WBS, RDM, RTM, Test Documentation, performance model, security documentation, test artifacts, audit results
Outputs:	Risk Watch List, findings
IV&V Standard Reference:	**2.5.1**

3.4.15 Construction Phase IV&V Metrics

The IV&V Team will continue to track metrics during this phase of development and will report any concerns or issues via an MOR or as part of the Risk Watch List, Issues Log or Weekly Status Report.

Task:	**Construction Phase IV&V Metrics**
Method:	During this phase, the metrics will focus on development and testing progress. Development metrics include changes to requirements. Any requirement changes will be tracked and monitored. All deviations from the schedule will be tracked, and significant slippage will be reported. Source code evaluation (total source lines of code or comparable measure of development estimation) will be used in a planned versus actual analysis. Test progress metrics will include a review of defects with trend analysis to assess time to correct. The test status of requirements and number of test cases completed will be tracked throughout testing. Requirement test status will be monitored by disposition, e.g., satisfied, failed, not tested, etc.
Inputs:	Business Case, RTM, source code, web pages, applets, WBS
Outputs:	**Metrics MOR, or inputs to regular status reporting and risk/issue logs**
IV&V Standard Reference:	**2.5.6**

3.4.16 Construction Phase Security Checklist Compliance Verification

The IV&V Team must review the results of all security reviews and will ensure that Security requirements are traced through the Business Case, RDM and detailed design, code and test cases. The IV&V Team will continue to work with the assigned System Security Officer and keep him/her abreast of any IV&V security issues.

Task:	Security Checklist Compliance Verification
Method:	At the end of the Construction Phase, the IV&V Team will ensure that the Security Construction Phase Checklist has been completed and signed off by the Security Officer and includes the completion of all security related activities including: • Draft System Security Plan • Draft Continuity of Operation Plan • Draft Disaster Recovery Plan • Draft System Security Authorization Agreement • Threat Analysis • Impact Analysis • Risk Assessment Corrective Action Plan • Final MOUs and SLAs • Completed User Background Investigation Clearance Form • Approved User Access Request Form • System Access Letter to Contractor employees
Inputs:	RTM, Operation Procedures, Test Results, SSAA, Completed Security Compliance Verification Checklist
Outputs:	**Findings**
IV&V Standard Reference:	**2.5.2, 2.5.10**

3.4.17 Construction Phase Section 508 Checklist Compliance Verification

Section 508 Review is to determine the degree of compliance with Section 508 of the Rehabilitation Act and associated amendments of 1998. The purpose of this follow-up review is to again verify that the test team is properly testing the Section 508 requirements and that any issues are highlighted prior to PRR.

Task:	Section 508 Compliance Review
Method:	The IV&V Team will evaluate the developer's approach to Section 508 compliance and determine if the requirements have been addressed and if the development team is coordinating with the Department of Education's internal Section 508 point of contact. This is not meant to be a review of the application for compliance, as this is performed internally by Education.

Task:	Section 508 Compliance Review
Inputs:	Section 508 Checklist, Reference Material
Outputs:	Part of Risk Watch List or MOR
IV&V Standard Reference:	**2.5.2, 2.5.3, 2.5.8**

3.4.18 Production Readiness Review Support

The FSA will hold a Production Readiness Review after migrating the system to the installation site. The IV&V Team will support the readiness review and verify the entrance and exit criteria. At the discretion of FSA, the IV&V Team will support a Functional Configuration Audit (FCA) and/or Physical Configuration Audit (PCA). An FCA is the formal examination of a hardware/software configuration item's functional characteristics (prior to acceptance) to verify that the item has achieved the performance specified in applicable functional and allocated requirements. The Government PCA is the formal examination of a hardware/software configuration item's physical characteristics used to establish the product or operational baseline. In addition, it provides an accounting of all aspects of the software delivery to the FSA. At the conclusion of the Production Readiness Review, the IV&V Team will make a recommendation as to whether the target system is ready for deployment.

Task:	Production Readiness Review Support
Method:	The IV&V Team will provide a recommendation as to whether the system is ready for operations at the readiness review. The IV&V Team will generate a checklist for entrance/exit criteria verification and will verify that all items are satisfied. The IV&V Team will also verify that action items are documented and tracked. In addition, the IV&V Team will review updated deployment plans. Production Readiness Review Criteria will include, as a minimum, the following: • Project value and success measures reasonably expected to be met or exceeded • Deployment procedures and programs tested • Accuracy and completeness of converted data • Severity and volume of open problems acceptable to proceed • IV&V report issues satisfactorily resolved
Inputs:	Test Results, IV&V Findings, Software and Hardware Inventory, Entrance Criteria, Exit Criteria, Tailored Criteria Checklist
Outputs:	**Completed Checklists, Findings, Recommendations**
IV&V Standard Reference:	**2.5.2, 2.5.3, 2.5.4**

3.5 SLC Deployment Phase

The Deployment Phase is the period of time in the system life cycle during which a hardware and/or software product goes into production and, if appropriate, is evaluated at the installation site to ensure that the product performs as required. Many operational support issues are under the domain of the VDC, and VDC procedures. The IV&V Team will support documentation reviews and the Transition to Support Readiness Review, as well as review maintainability of the system. To support the FSA during the Deployment Phase, the IV&V Team will:

- Evaluate Deployment Phase documents and updated design and test materials, including a final EDNET maintenance review
- Support the Transition to Support Readiness Review
- Monitor any necessary system changes and regression testing
- Monitor installation and regression testing (if appropriate) and evaluate the results
- Verify Deployment Phase Security Checklist Compliance
- Generate IV&V Final Report and Lessons Learned

3.5.1 Deployment Phase Document Reviews

The IV&V Team will review documentation delivered during the Deployment Phase. This will include the final program package and accompanying documentation and results of configuration audits.

Task:	**Deployment Phase Document Reviews**
Method:	The developer will submit the final program package prior to delivering the product to the installation site. The IV&V Team will evaluate the program package, including User Manuals and Version Description Document (VDD) if available. The final program package may also include change pages to documentation. The IV&V Team will also evaluate any anomaly reports for severity and all resulting software changes to determine the system impact and ensure the correct implementation and distribution of revised documentation. Based on system impact determinations, IV&V tasks may be iterated as necessary to validate the software. In the process of evaluating anomalies and approved changes, the IV&V Team will verify that no unacceptable changes to software performance have occurred. These documents will be reviewed for correctness and consistency. Documents reviewed include TTS materials, training materials, and final maintenance documentation.
Inputs:	Final Program Package, Anomaly Reports, System and User Documentation, VDD, Updated Design Documents for maintenance, TTS Readiness Materials, Training Material, Configuration Inventories, Project Inventory List, Service Level Agreements, MOUs, Document Review Checklist

Task:	Deployment Phase Document Reviews
Outputs:	**Completed Checklists, Findings**
IV&V Standard Reference:	**2.5.3**

3.5.2 Transition to Support (TTS) Readiness Verification

The purpose of the Transition to Support is to plan, manage and complete support readiness activities. The IV&V Team will participate in the TTS and will verify that the SLC provided TTS checklist items are met and that the SLC's TTS readiness materials are completed.

Task:	Transition to Support (TTS) Readiness Verification
Method:	The IV&V Team will review the TTS Readiness Materials including the project inventory list, TTS schedules, SLA agreements and training materials. In addition, the IV&V team will audit the document library to ensure that it contains the latest versions of the controlled documents needed for maintenance. Lastly, IV&V will verify that all executive sign-off elements are addressed. Prior to the completion of the Deployment Phase and executive sign-off, the following exit criteria will be verified by IV&V: • Solution has been successfully deployed • Project Inventory List is baselined • TTS Readiness Review is completed and approved • SLC Security Deployment Phase Checklist is completed and approved • System Security Plan is complete • Configuration Item Index is baselined • MOUs/SLAs are established and approved • Training Plan is in place
Inputs:	TTS Readiness Materials, Training Materials, Configuration Inventories, Project Inventory List, Security Phase Checklist, Service Level Agreements, MOUs, Executive Sign-off Sheet
Outputs:	**Completed Checklists, Findings, Sign-off recommendation**
IV&V Standard Reference:	**2.5.2, 2.5.3, 2.5.4**

3.5.3 Regression Test Monitoring

The IV&V Team will monitor the developer's regression tests required for any changes to the system. Once the hardware or the software has been fixed, regression testing must be performed.

The IV&V Team will assure that all test results are obtained in the approved hardware/software environment. The IV&V Team will verify the implementation of configuration management controls, contingency planning, and anomaly tracking. In addition, the IV&V Team will assess the need for regression testing throughout this life cycle phase.

Task:	**Regression Test Monitoring**
Method:	The IV&V Team will observe regression testing and verify successful re-execution of formal procedures. The IV&V Team will verify that configuration management procedures are followed through mini-audits of defect tracking and code control. The IV&V Team will verify that contingency plans are in effect. Regression testing will be observed and any failures during testing will be evaluated. Failures detected will be reviewed to determine why the failure occurred, to identify code and documentation changes, to determine which tests need to be repeated, to isolate changes made to existing tests, and to uncover new tests which must be developed. This analysis will be performed using the following procedures: • Observe the repeatability of the test to verify the invalid results. • Ensure that the test failure is documented in the test logs or other documentation with cross-references to any problem reports. • Evaluate the test output with the expected results for possible errors. If the test procedure is in error, a problem report must be generated to correct the documentation error. Testing resumes after successfully repeating the test with the corrected procedure. • When the software is in error, an analysis is necessary to determine whether to halt all testing pending software correction, resume testing using redlined test procedures, develop new test procedures, or use a work-around that avoids the failed portion. • Follow all of the guidelines required for a formal test activity.
Inputs:	**Anomaly Reports, Test Procedures and Results, CM Plans, Process Audit (CM) Sample Checklist**
Outputs:	Completed Checklist, Findings
IV&V Standard Reference:	**2.5.4, 2.5.9, 2.5.12**

3.5.4 Installation Configuration Audit

At the discretion of FSA, IV&V can audit the installation of the system to verify that correct versions of software are installed and procedures are followed. The IV&V Team's involvement during installation will include monitoring the system installation and verifying that there is configuration control of the environment and system changes. The IV&V Team will also verify that system cutover plans and contingency planning (fallback positions) exist. The IV&V Team will track lessons learned and capture them in each IV&V Final Report provided to FSA.

Task:	Installation Configuration Audit
Method:	In support of any configuration audits in support of TTS, a checklist will be generated to ensure that the developer's plans, products, technical documentation, and reports are formally accepted. This will aid in providing evidence that all the requirements have been satisfied and that the evidence verifies the Configuration Item's system performance and functionality against its approved configuration documentation. The IV&V Team will provide summary data for all previously completed IV&V activities, ensure that the audit conduct follows established standards and published agenda, and assist in the performance of the configuration audit.
Inputs:	Final RTM, TTS Readiness Materials, Configuration Inventories, Project Inventory List, Inventory Checklist
Outputs:	**Completed Checklists, Findings**
IV&V Standard Reference:	**2.5.3, 2.5.8**

3.5.5 Deployment Phase Security Checklist Compliance Verification

The IV&V Team must review the results of all security reviews and will ensure that Security requirements are traced through the Business Case, RDM, code and test results. The IV&V Team will continue to work with the assigned System Security Officer and keep him/her abreast of any IV&V security issues.

Task:	Deployment Phase Security Checklist Compliance Verification
Method:	At the end of the Deployment Phase, the IV&V Team will ensure that the Security Deployment Phase Checklist has been completed and signed off by the Security Officer and includes the completion of all security related activities including: • Documented completion of CAP from Construction Phase • Completed Security Test Plan • Documented Security Test Results • Certification Letter • Signed Accreditation Letter • Final System Security Plan • Final Continuity of Operations Plan • Final Disaster Recovery Plan • User Training Schedule • Approved User Access Request Forms
Inputs:	Business Case, RTM, Assignment Letters, Business Partner List, Requirements Matrices, Completed Security Compliance Verification

	Checklist
Task:	**Deployment Phase Security Checklist Compliance Verification**
Outputs:	**Findings**
IV&V Standard Reference:	**2.5.2, 2.5.10**

3.5.6 Risk Analysis

The IV&V Team will continue to monitor program risks and will maintain a risk watch list. The risk watch list should be delivered to the Mod Partner on a regular basis, and the IV&V team should review all outstanding risks with the FSA and Development Program Managers.

Task:	Risk Analysis
Method:	The IV&V Team will continue to maintain an independent risk watch and recommend mitigation strategies. Risk areas will continue to be focused on schedule, cost, performance, future maintenance, training, and staff availability as the project comes to conclusion.
Inputs:	Current Plans, RTM, RDM, Test Results, WBS, developer staffing plan
Outputs:	Risk Watch List, findings
IV&V Standard Reference:	**2.5.1**

3.5.7 IV&V Final Report and Lessons Learned Generation

The IV&V Team will prepare an IV&V Final Report.

Task:	**IV&V Final Report and Lessons Learned Generation**
Method:	During this phase, the IV&V Team will prepare a Final Report documenting all of their findings, including detailed lessons learned. A sample format for this report is included in Section 5.
Inputs:	Risk Watch List, Issues Log, Findings, Lessons Learned
Outputs:	**IV&V Final Report**
IV&V Standard Reference:	**2.5.6**

3.5.8 Deployment Phase IV&V Metrics

The IV&V Team will continue to track metrics during this phase of development and will report any concerns or issues via an MOR or as part of the Risk Watch List, Issues Log, or Weekly Status Report.

Task:	Deployment Phase IV&V Metrics
Method:	The metrics during this phase will pertain to system installation, performance and maintenance issues. Typically the IV&V Team will track adherence to schedule, regression test progress and defect tracking.
Inputs:	Business Case, RTM, WBS, maintenance statistics, support data
Outputs:	**Metrics MOR, or inputs to regular status reporting and risk/issue logs**
IV&V Standard Reference:	**2.5.6**

3.6 SLC Support Phase

The System Support Phase is the period of time during which the FSA upgrade or iteration is evaluated from an operational and maintainability standpoint. Traditionally, this has been an area that is primarily the responsibility of the VDC. For smaller desktop systems that are part of the FSA network, the IV&V Team can evaluate the performance of the tool and address continued maintenance issues. In addition, the IV&V Team can participate in the Post Implementation Review. The level of Support Phase participation by the IV&V Team is dependent upon access to the environment. Some of the benefits IV&V can provide during the SLC Support Phase are:

- Performance of updated document reviews
- Verification of the Security Support Phase Checklist
- Post Implementation Review Support

3.6.1 Support Phase Document Reviews

The IV&V Team will review maintenance and support documentation, anomaly reports, applicable regression test results, and the milestone review document and checklist. Help Desk documentation and updated training materials are also reviewed.

Task:	Support Phase Document Reviews
Method:	The primary focus will be on maintenance and operational documentation. These include final versions of technical documents, operational procedures, and training documentation. Documents will be reviewed based on the Document Review Checklist. This checklist will be tailored as needed.
Inputs:	Final Program Package, Anomaly Reports, System and User Documentation, VDD, Lessons Learned, Document Review Checklist

Task:	Support Phase Document Reviews
Outputs:	Completed Checklist, Findings, Additional Lessons Learned
IV&V Standard Reference:	**2.3.3, 2.3.11, 2.3.12**

3.6.2 Post Implementation Review

The IV&V Team will provide lessons learned in support of the Post Implementation Review. A briefing of the IV&V final report can be provided at the discretion of FSA. The IV&V Team will assess whether program objectives were met in addition to evaluating the overall development and management processes. The IV&V Team will monitor system utilization and ensure that a problem and change request tracking system is in place.

Task:	Post Implementation Review
Method:	In support of the Post Implementation Review, the IV&V Team will generate a checklist to verify entrance and exit criteria. The IV&V Team will review metrics and lessons learned prior to the review. The IV&V Team will continue to monitor any outstanding defects and/or risks that may impact the deployed target system and provide feedback to FSA. Post Implementation Review Criteria must include assurance that project value and success measures have been reasonably met or exceeded.
Inputs:	**Metrics, IV&V Findings, Lessons Learned, Tailored Criteria Checklist**
Outputs:	Completed Checklist, Findings, Recommendations
IV&V Standard Reference:	**2.5.1, 2.5.3, 2.5.4, 2.5.6, 2.5.12**

3.6.3 Support Phase Security Checklist Compliance Verification

The IV&V Team must review the results of all security reviews and will ensure that Security requirements are traced through the Business Case, RDM and preliminary design. The IV&V Team will continue to work with the assigned System Security Officer and keep him/her abreast of any IV&V security issues.

Task:	Support Phase Security Checklist Compliance Verification
Method:	At the end of the Support Phase, the IV&V Team will ensure that the Security Support Phase Checklist has been completed and signed off by the Security Officer and includes the completion of all security related activities including: • Re-certified and accredited SSAA • Documented completion of final test results

	• Updated Operation Procedures • Updated Testing Results
Inputs:	RTM, Operation Procedures, Test Results, SSAA, Completed Security Compliance Verification Checklist
Outputs:	**Findings**
Task:	**Support Phase Security Checklist Compliance Verification**
IV&V Standard Reference:	**2.5.2, 2.5.10**

3.6.4 Risk Analysis

The IV&V Team will continue to monitor program risks and will maintain a risk watch list. The risk watch list should be delivered to the Mod Partner on a regular basis and the IV&V team should review all outstanding risks with the FSA and Development Program Managers. The more involved the program managers are in the process of risk assessment, the more likely all of the key risks will be identified.

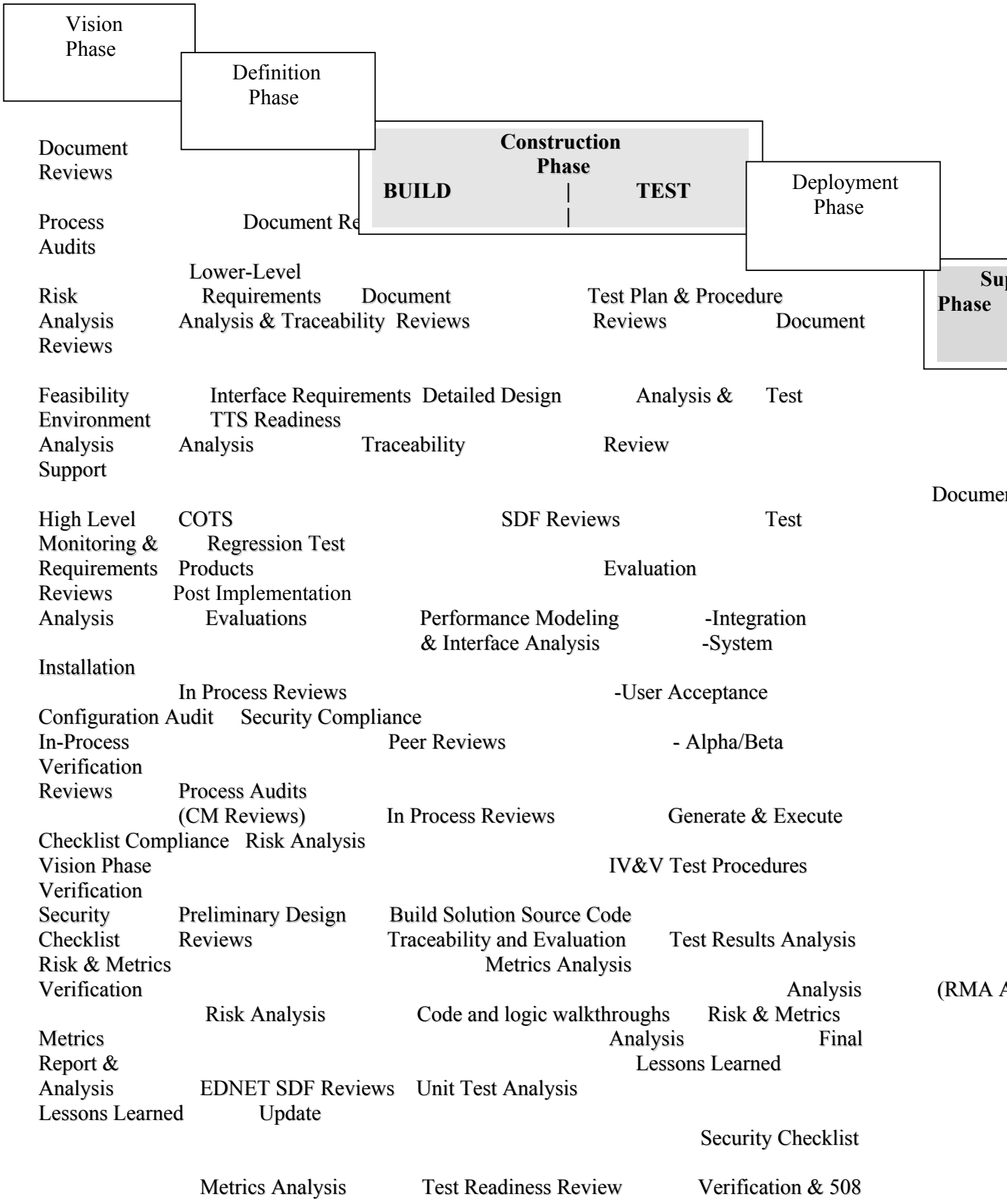
Task:	Risk Analysis
Method:	The IV&V Team will continue to maintain an independent risk watch and recommend mitigation strategies. The focus of risk assessment will be performance and operational, as well as reliability and availability issues.
Inputs:	Current Plans, WBS, GFE and/or COTS Technologies Documentation, SAP, Business Case
Outputs:	Risk Watch List
IV&V Standard Reference:	**2.5.1**

3.6.5 Support Phase IV&V Metrics

The IV&V Team will continue to track metrics during this phase of development and will report any concerns or issues via an MOR or as part of the Risk Watch List, Issues Log or Weekly Status Report.

Task:	**Support Phase IV&V Metrics**
Method:	During this phase, the metrics continue to focus on availability, reliability and maintainability (RMA) issues. In addition, requirements will be monitored in terms of future upgrades and enhancement. Help Desk support may also be addressed as part of risk assessment.
Inputs:	RMA statistics, operational support data, audit results, performance data, and Help Desk Records

Outputs:	**Metrics MOR, or inputs to regular status reporting and risk/issue logs**
IV&V Standard Reference:	**2.5.6**


Vision Phase
Definition Phase
Construction Phase
BUILD | TEST
Deployment Phase
Su
Phase
Document Reviews
Process Audits
Document Re
Lower-Level Requirements Analysis & Traceability
Risk Analysis
Document Reviews
Test Plan & Procedure Reviews
Document Reviews
Feasibility Analysis
Interface Requirements Analysis
Detailed Design
Analysis & Traceability
Test Environment Support
TTS Readiness Review
Documer
High Level Requirements Reviews
COTS Products
SDF Reviews
Test Evaluation
Monitoring & Post Implementation Evaluations
Regression Test Analysis
Performance Modeling & Interface Analysis
-Integration
-System
-User Acceptance
-Alpha/Beta
Installation
In Process Reviews
Configuration Audit
Security Compliance
In-Process Verification Reviews
Peer Reviews
Process Audits (CM Reviews)
In Process Reviews
Generate & Execute IV&V Test Procedures
Checklist Compliance
Risk Analysis
Vision Phase Verification
Security Checklist
Preliminary Design Reviews
Build Solution Source Code Traceability and Evaluation
Test Results Analysis
Risk & Metrics Verification
Metrics Analysis
Analysis
(RMA A
Risk Analysis
Code and logic walkthroughs
Risk & Metrics Analysis
Metrics
Final Report & Lessons Learned Analysis
EDNET SDF Reviews
Unit Test Analysis
Lessons Learned Update
Metrics Analysis
Test Readiness Review
Verification & 508

Review

Security Checklist Verification

and Section 508 Compliance

Production Readiness

MANAGEMENT & PROCESS IMPROVEMENT ACTIVITIES

SECURITY ANALYSIS, VERIFICATION OF ENTRANCE & EXIT CRITERIA ,SUPPORT IN PROCESS REVIEWS/IT
METRICS, RISK, ANALYSIS, IPT SUPPORT & ANOMALY REPORTING

GLOSSARY

Acceptable Risk

Acceptable risk is a concern that is acceptable to responsible management, due to the cost and magnitude of implementing countermeasures.

Acceptance Test

Formal testing conducted to determine whether or not a system satisfies its user acceptance criteria and to enable the customer to determine whether or not to accept the system.

Accreditation

Accreditation is the authorization and approval granted to a major application or general support system to process in an operational environment. It is made on the basis of a certification by designated technical personnel that the system meets pre-specified technical requirements for achieving adequate system security. See also Authorization to Process**,** Certification and Designated Approving Authority.

Alpha Test

First stage of user testing which focuses on user feedback and on the quality and usability of the product. Involves a first attempt to use the application in the work environment.

Anomaly

Anything observed in the documentation or operation of software that deviates from expectations based on previously verified products or reference documents. A critical anomaly is one that must be resolved before the verification and validation effort proceeds to the next life cycle phase. Also called an Incident.

Anomaly Report

A report that identifies a program that is not in conformance with design specifications or that is causing mission degradation because of its design. These may be used to document anomalies as well as proposed enhancements. Also called an Incident Report.

Audit

An independent examination of a work product or set of work products to assess compliance with specifications, standards, contractual agreements, or other criteria.

GLOSSARY (Cont'd)

Authorization to Process

Authorization to process occurs when management authorizes a system based on an assessment of management, operational and technical controls. By authorizing processing in a system the management official accepts the risk associated with it. See also Accreditation, Certification, and Designated Approving Authority.

Availability Protection

Protection of system availability requires backup of system components and information, contingency plans, disaster recovery plans, and redundancy. Examples of systems and information requiring availability protection are time-share systems, mission-critical, time and attendance, financial, procurement, or life-critical applications.

Baseline

A specification or product that has been formally reviewed and agreed upon, that thereafter serves as the basis for further development, and that can be changed only through formal change control procedures.

Beta Test

Final stage of user testing that consists of a larger set of users to further stress test the system before deployment into the full-scale production environment. As with the Alpha test, the Beta test involves using the application in a work environment.

Build and Test

The software development life cycle phase during which the detailed design is converted into a language that is executable by a computer. This is also called the Implementation Phase.

Capacity Testing

Attempts to simulate expected customer peak load operations in order to ensure that the system performance requirements are met. It does not necessarily exercise all of the functional areas of the system, but selects a subset that is easy to replicate in volume. It will ensure that functions which are expected to use the most system resources are adequately represented.

Capability Maturity Model

Describes the principles and practices underlying software process maturity and is intended to help software organizations improve the maturity of their software processes in terms of an evolutionary path from ad hoc, chaotic processes to mature, disciplined software processes.

GLOSSARY (Cont'd)

Certification

Certification is synonymous with the phrase "authorization to process." Certification is the technical evaluation that establishes the extent to which a computer system, application, or network design and implementation meet a pre-specified set of security requirements.

Computer Software Configuration Item

An aggregation of software that is designated for configuration management and treated as a single entity in the configuration management process.

Confidentiality Protection

Protection of confidentiality requires access controls such as user ID/passwords, terminal identifiers, restrictions on actions like read, write, delete, etc. Examples of confidentiality-protected information are personnel, financial, proprietary, trade secrets, internal agency, investigations, other federal agency, national resources, national security, and high or new technology under Executive Order or Act of Congress.

Configuration Control

An element of configuration management, consisting of the evaluation, coordination, approval or disapproval, and implementation of changes to configuration items after formal establishment of their configuration identification.

Configuration Control Board

A group of people responsible for evaluating and approving/disapproving proposed changes to configuration items, and for ensuring implementation of approved changes.

Configuration Item

An aggregation of hardware, software, or both, that is designated for configuration management and treated as a single entity in the configuration management process.

Configuration Management

A discipline applying technical and administrative direction and surveillance to: identify and document the functional and physical characteristics of a configuration item, control changes to those characteristics, record and report change processing and implementation status, and verify compliance with specified requirements.

GLOSSARY (Cont'd)

Construction Phase

The objective of the SLC Construction Phase is to develop and test a solution that meets the requirements defined in the previous phase, as well as the approved Business Case.

Critical Defect

An error, omission, or other problem found with the review materials which impacts the ability of the document to achieve the defined scope.

Critical Design Review

A review conducted during the Construction Phase to verify that the detailed design of one or more configuration items satisfies specified requirements; to establish the compatibility among the configuration items and other items of equipment, facilities, software, and personnel; to assess risk areas for each configuration item; and, as applicable, to assess the results of producibility analyses, review preliminary hardware product specifications, evaluate preliminary test planning, and evaluate the adequacy of preliminary operation and support documents. The end result of this review is an approved detailed design of the system.

Defect

A flaw in a system or system component that causes the system or component to fail to perform its required function.

Definition Phase

The Definition Phase is the period of time during which the Business Case Requirements are further defined into lower level requirements and a preliminary design. As this phase proceeds, many of the functional and performance capabilities are further defined and documented in the developer RDM, Business Case and Performance Model

Deployment Phase

The Deployment Phase is the period of time in the system life cycle during which a hardware and/or software product goes into production and is evaluated at the installation site to ensure that the product continues to perform as required. Many of operational support issues are under the domain of the VDC, and the VDC procedures.

Designated Approving Authority (DAA)

The DAA is the senior management official who has the authority to authorize processing (accredit) an automated information system and accept the risk associated with the system.

GLOSSARY (Cont'd)

Detailed Design

The period of time in Construction Phase during which the detailed designs for architecture, software components, interfaces, and data are created, documented, and verified to satisfy requirements.

Deviation

A departure from a specified requirement. A written authorization, granted prior to the manufacture of an item, to depart from a particular performance or design requirement for a specific number of units or a specific period of time.

Entrance/Exit Criteria

Conditions that need to be satisfied for a phase or product to start and to be considered complete, respectively.

Firewall

A firewall is a system (or network of systems) specially configured to control traffic between two networks. A firewall can range from a packet filter to multiple filters, dedicated proxy servers, logging computers, switches, hubs, routers and dedicated servers.

Functional Configuration Audit

An audit conducted to verify that the development of a configuration item has been completed satisfactorily, that the item has achieved the performance and functional characteristics specified in the functional or allocated configuration identification, and that its operational and support documents are completed and satisfactory.

Gateway

A gateway is a secured computer system that provides access to certain applications. It cleans outgoing traffic, restricts incoming traffic and may also hide the internal configuration from the outside.

General Support System (GSS)

A GSS is an interconnected information resource under the same direct management control that shares common functionality. It normally includes hardware, software, information, data, applications, communications, facilities, and people and provides support for a variety of users and/or applications. Individual applications support different mission-related functions. Users may be from the same or different organizations.

Independent Verification and Validation

Verification and validation of a software product by an organization that is both technically and managerially separate from the organization responsible for developing the product.

Individual Accountability

Individual accountability requires individual users to be held responsible for their actions after being notified of the rules of behavior in the use of the system and the penalties associated with the violation of those rules.

Information Security

Information security is the preservation of confidentiality, integrity, and availability. Each of these attributes is defined as follows:

- Confidentiality – ensuring that information is accessible only to those authorized to have access
- Integrity – safeguarding the accuracy and completeness of information and processing methods
- Availability – ensuring that authorized users have access to information and associated assets when required

Integrated Product Team

A multidisciplinary teamwork approach consisting of representatives from all appropriate functional disciplines working together with a team leader to build successful and balanced programs, identify and resolve issues, and make sound and timely decisions.

Integration Test

The period of time in the life cycle during which product components are integrated and the product is evaluated to determine whether target system requirements have been satisfied. The focus of this test is on how multiple components work together and the functions of the system. It will also test the user screens and system interfaces.

Iteration

The process of repeatedly performing a sequence of steps.

GLOSSARY (Cont'd)

Issue

A problem or concern which can't be directly addressed by modifying the review materials. It may affect another unit or group, or other products, and may contain recommendations for future improvements.

Lessons Learned

Summary of the problems encountered during a project, attempted solutions, and the resulting failures and successes. The summary should include the failure or success of the project tools, procedures, and methods.

Life cycle Model

A framework containing the processes, activities, and tasks involved in the development, operation and support of a system, spanning the life of the system from the definition of its requirements to the termination of its use.

Life cycle Phase

Any period of time during software development or operation that may be characterized by a primary type of activity (such as design or testing) that is being conducted. [Note: These phases may overlap one another; for IV&V purposes, no phase is concluded until its development products are fully verified.]

Major Application

A major application is a system that requires special attention to security due to the risk and magnitude of the harm resulting from the loss, misuse, or unauthorized access to or modification of the information in the application. A breach in a major application might comprise many individual application programs and hardware, software, and telecommunications components. Major applications can be either a major software application or a combination of hardware/software where the only purpose of the system is to support a specific mission-related function.

Metric

A quantitative measure of the degree to which a system, component or process possesses a given attribute.

Minor Defect

An error, omission, or other problem found with the review materials whose impact appears to be minimal.

Modified Waterfall Methodology

There are different versions of this method but they may approach the problem by modifying the traditional "pure" waterfall approach by allowing the steps to overlap, reducing the documentation, and allowing more regression. Some of the more useful versions are:

Overlapping Waterfall - steps overlap allowing discovery and insight in later stages; i.e. the requirements analysis may still be occurring partway into the Detailed Design stage. This mirrors many real-life projects.

Waterfall with Subprojects - the architecture is broken into logically independent subsystems that can be done separately and integrated together later in the project. This allows each subproject to proceed at it's own pace rather than having to wait for all subprojects to have reached the same stage or readiness before proceeding to the next stage.

Waterfall with Risk Reduction - a risk reduction spiral (see Spiral Development below) is introduced at the requirements stage and/or the architectural stage.

Module

A program unit that is discrete and identifiable with respect to compiling, combining with other units, and loading. Note: The terms 'module', 'component', and 'unit' are often used interchangeably or defined to be sub-elements of one another in different ways depending on the context.

Networks

Networks include a communication capability that allows one user or system to connect to another user or system and can be part of a system or a separate system. Examples of networks include local area networks or wide area networks, including public networks such as the Internet.

Operational Controls

Operational controls address security mechanisms that are primarily executed by people (as opposed to systems).

GLOSSARY (Cont'd)

Packet Filter

A packet filter stops or allows packets to flow between two networks according to predefined rules. A simple packet filter is a router. It works on the network layer of the Open Systems Interconnect (OSI) model.

Performance Test

The period of time in the system/software development life cycle during which the response times for the application are validated to be acceptable. The tests ensure that the systems environment will support production volumes, both batch and on-line.

Physical Configuration Audit

An audit conducted to verify that a configuration item, as-built, conforms to the technical documentation that defines it.

Post Implementation Review

A milestone review to evaluate the project outcome to verify whether the project achieved the desired results and met predicted strategic outcome measures within the planned cost and schedule.

Preliminary Design Review

A review conducted during the Definition Phase to evaluate the progress, technical adequacy, and risk resolution of the selected top level design approach for one or more configuration items; to determine each design's compatibility with the requirements for the configuration item; to evaluate the degree of definition and assess the technical risk associated with the selected manufacturing methods and processes; to establish the existence and compatibility of the physical and functional interfaces among the configuration items and other items of equipment, facilities, software and personnel; and, as applicable, to evaluate the preliminary operational and support documents.

Prototyping Methodology

The system concept is developed as the development team moves through the project by developing and demonstrating part of the system, usually the most visible part, to the customer. Modifications may be made and the next part is then developed based on feedback from the customer. At some point, agreement is reached between the customer and the developer that the prototype is satisfactory and outstanding work is finished and the system delivered.

Preliminary System Design

The portion of the Definition Phase during which the top level designs for architecture, software components, interfaces, and data are created, documented, and verified to satisfy requirements.

Production Readiness Review

A review conducted to review feedback from customer sponsors and to review system performance compared to anticipated value and success measures. The review assesses the readiness of technology infrastructure, as well as the readiness of affected organizations.

Proxy

A proxy is a program which allows/disallows access to a particular application between networks. It works on the Application layer of the OSI model.

Rapid Application Development Methodology

Rapid Application Development Methodology is a term often used without being clearly defined. It may mean rapid prototyping to one user, the use of CASE tools and tight deadlines to another, or a headline article in a trade journal to a third. As a useful term in a strategic sense, the best usable definition is that RAD means a project that requires an accelerated development environment compared to more traditional project modes and timelines. It requires more careful management and better understanding of the risks involved. Using this definition frees RAD of association with any one set of tools and focuses on the relationship between software development methods within specific environments especially in relation to time constraints.

Regression Testing

The rerunning of test cases that a program has previously executed correctly in order to detect errors created during unrelated software correction or modification activities.

Risk

Risk is the possibility of harm or loss to any software, information, hardware, administrative, physical, communications, or personnel resource within an automated information system or activity.

GLOSSARY (Cont'd)

Risk Assessment

Risk assessment is the structured analysis of threats to, impacts on and vulnerabilities of information and information processing facilities and the likelihood of their occurrence.

Risk Management

An approach to problem analysis which weighs risk in a situation by using risk probabilities to find a more accurate understanding of the risks involved. Risk management includes risk identification, analysis, prioritization, and control.

Rules of Behavior

These are the rules that have been established and implemented concerning use of, security in, and acceptable level of risk for the system. Rules will clearly delineate responsibilities and expected behavior of all individuals with access to the system. Rules should cover such matters as work at home, dial-in access, connection to the Internet, use of copyrighted works, unofficial use of federal government equipment, the assignment and limitation of system privileges, and individual accountability.

Sensitive Information

Sensitive information refers to information that requires protection due to the risk and magnitude of loss or harm that could result from inadvertent or deliberate disclosure, alteration, or destruction of the information. The term includes information whose improper use or disclosure could adversely affect the ability of an agency to accomplish its mission, proprietary information, records about individuals requiring protection under the Privacy Act, and information not releasable under the Freedom of Information Act.

Sensitivity

Sensitivity in an information technology environment consists of the system, data, and applications that must be examined individually and in total. All systems and applications require some level of protection for confidentiality, integrity, and availability. This level is determined by an evaluation of the sensitivity and criticality of the information processed, the relationship of the system to the organization's mission, and the economic value of the system components.

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GLOSSARY (Cont'd)

Software Development

A set of activities that results in software products. Software development may include new development, modification, reuse, reengineering maintenance, or any other activities that result in software products

Software Development Folder

A repository for material pertinent to the development of a particular body of software. Contents typically include (either directly or by reference) considerations, rationale, and constraints related to requirements analysis, design, and implementation; developer-internal test information; and schedule and status information. The contents are usually stored on EDNETor within a development tools such as the Rational Suite.

Software Life cycle

Period of time from software product conception to when the software is no longer available for use. The software life cycle typically includes a concept design phase, system requirements analysis phase, preliminary and detailed design phases, build and test phase, integration and acceptance test phases, and a system deployment phase.

Software Process Assessment

Appraisal to determine the state of an organization's current software development process, to determine the high-priority software process-related issues facing an organization, and to obtain the organizational support for software process improvement.

Spiral Development Methodology

This is a risk-oriented method that breaks a project into smaller "miniprojects". Each miniproject focuses on one or more identified major risks in a series of iterations until all risks have all been addressed. Once all the risks have been addressed, the spiral model terminates the same way the waterfall model does.

Staged Delivery Development Methodology

This bears some similarities to both Prototyping and Waterfall with Subprojects in that software is demonstrated and delivered to the customer in successive stages. The steps up to and through architectural design are the same as the Traditional Waterfall and the following build and deliver steps are done for each of the separate stages. It differs from Prototyping in that the scope is

established at the beginning of the project and the software is delivered in stages rather than in one package at the end as is done with the waterfall method. It differs from Waterfall with Subprojects in that the stages are delivered independently rather than integrated towards the end of the project.

Standards

Guidelines employed and enforced to prescribe a disciplined, uniform approach to software development and its associated products.

Support Phase

The objective of the Support Phase is to smoothly operate the new business capabilities that were created and deployed. When this phase begins, the solution has been defined, created and deployed.

System

System is a generic term used for brevity to mean either a major application or a general support system.

System Operational Status

System operational status is either (a) Operational - system is currently in operation, (b) Under Development - system is currently under design, development, or implementation, or (c) Undergoing a Major Modification - system is currently undergoing a major conversion or transition.

System Requirements Review

A review conducted to evaluate the completeness and adequacy of the requirements defined for a system; to evaluate the system engineering process that produced those requirements; to assess the results of system engineering studies; and to evaluate system engineering plans.

System Test

The System Test is the period of time in the life cycle during which the product is evaluated to determine whether functional and performance requirements have been satisfied.

System Trouble Report

A report that identifies a program that is not in conformance with design specifications or that is causing mission degradation because of its design. These may be used to document anomalies as well as proposed enhancements. Also called an Incident Report.

Target System

The target system is the subject of the security assessment.

Technical Controls

Technical controls consist of hardware and software controls used to provide automated protection to the system or applications.

Test Readiness Review

A milestone review to determine that the software test procedures for each configuration item are complete and to ensure that the software developer is prepared for software performance testing. Entry criteria are reviewed and verified to be complete. Examples include Integration Test Readiness Review, Acceptance Test Readiness Review, and Production Test Readiness Review.

Threat

Threat is an activity, deliberate or unintentional, with the potential for causing harm to an automated information system or activity.

Traceability

Degree to which a relationship can be established between two or more products of the development process, especially products having a predecessor, successor, or master-subordinate relationship to one another (e.g., the degree to which the requirements and design of a given software component match).

Unit

The lowest element of a software hierarchy that contains one or more of the following characteristics: (1) a unit comprising one or more logical functional entities, (2) an element specified in the design of a computer software component that is separately testable, (3) the lowest level to which software requirements can be traced, and (4) the design and coding of any unit can be accomplished by a single individual within the assigned schedule.

Unit Test

The process of ensuring that the unit executes as intended. This usually involves testing all statements and branch possibilities.

Validation

Determination of the correctness of the final program or software produced from a development project with respect to the user's needs and requirements. Validation answers the question, "Am I building the right product?"

Verification

The process of determining whether the products of a given phase of the software development cycle fulfill the requirements established during the previous phase. Verification answers the question, "Am I building the product right?"

Vision Phase

The Vision Phase is the initial system life cycle phase during which user needs are documented and evaluated. Key documentation for this phase includes statement of objectives, Solution Acquisition Plan, Business Case, feasibility studies. This phase results in a completed Solution Acquisition Plan and Business Case.

Vulnerability

Vulnerability is a flaw or weakness that may allow harm to occur to an automated information system or activity.

Walkthrough

An informal review conducted to assess the development approach, the product and engineering practices applied, the completeness and correctness of capabilities and features, and the rules of construction for the target system products. Examples of specific types of walkthroughs include requirements walkthroughs, design walkthroughs, and source code walkthroughs.

Waterfall Development Methodology

In this model, the oldest and still one of most commonly used, the project proceeds through a series of separate sequential steps starting with the concept and ending with implementation. There is usually a review at the end of each step to determine if it is acceptable to proceed to the next step. If it is found that the project is not ready to proceed, the project is held in the current step until it is ready. In the pure form of this methodology, the different steps do not overlap.

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Appendix A

IV&V CHECKLISTS

APPENDIX A. IV&V CHECKLISTS

Standard checklists are fundamental tools maintained by the IV&V Team for use during evaluations. They may be used as is, or tailored as necessary.

Checklist Name	Checklist Description
Document Review Checklist	This checklist is used as a generic checklist for documentation reviews and should be tailored to match the type of document under review. It is an aid to determining the overall quality of a document as to readability, utility, correctness, and completeness.
Requirements Review Checklist	This checklist is used to determine whether a given concept, set of requirements, design, test, etc., demonstrates that a CSCI or system satisfies its specified acceptance requirements.
Preliminary Design Checklist	This checklist is used to aid in assessing the top-level design as well as the allocation of requirements to software components, and to determine whether the Preliminary Design Review (PDR) resolved open issues concerning the handling of high-level design requirements.
Detailed Design Checklist	This checklist is used to aid in determining if all the software requirements have been translated into a viable software design, and whether the Critical Design Review (CDR) resolved open issues concerning the handling of critical requirements
Process Audit (CM) Sample Checklist	This is a sample process audit checklist with an emphasis on Configuration Management (CM) practices. This checklist is used to determine whether CM Procedures document and implement plans for: performing configuration control; providing access to documentation and code under configuration control; and controlling the preparation and dissemination of changes to master copies of software and documentation so they reflect only approved changes.
Code Review Checklist	This checklist suggests evaluation criteria used to determine whether the software design has been correctly implemented in code that adheres to programming standards and conventions.
Unit Testing Review/Audit Checklist	This checklist is used to determine whether: adequate test procedures to test each Computer Software Unit were developed and documented; each unit was coded and tested ensuring that the algorithm(s) and logic employed are correct and satisfy the specified requirements; all necessary revisions to the design documentation and code were made; all necessary retesting was performed; and test results were recorded.

APPENDIX A. IV&V CHECKLISTS

SDF Audit Checklist (EDNET)	This checklist is used to determine whether Software Development Files (SDF) contain material pertinent to the development or support of the software including: requirements, design considerations, constraints, documentation, PDL and source code, test data; status information; and test requirements, cases, procedures, and their results.
Test Readiness Review Checklist	This checklist is for evaluating the Test Readiness Review (TRR) to ensure that adequate preparations were taken for the performance of System Integration Test, and System Acceptance Testing.
Section 508 Review Checklist	This checklist is for performing a Section 508 assessment. It is included here to provide guidance to the IV&V Team as to the Section 508 requirements.

DOCUMENT REVIEW CHECKLIST

The purpose of document reviews is to verify that the technical documents and plans are consistent with project plans, requirements and guidelines established by FSA. This checklist must be tailored for each document, but sample product assessment guidelines are provided.

IV&V Engineer:_____ Date: _____

Project:_____ Phase: _____

Item #	Criterion	(Y/N) Record References to Non-Compliant Items
1	Is the document written to the appropriate level of detail?	
2	Is the document consistent with other predecessor documents?	
3	Is the material within this document feasible as stated?	
4	Are all required paragraphs included in the document? (Is the document compliant with DID or standard)? Add tailoring here to meet standard.	
5	Are all sections in the proper order?	
6	Does each section contain the proper content?	
7	Is the document in compliance with required SOW? CDRL? Contract?	
8	Are all statements compatible and consistent?	
9	Is the level of detail and presentation style consistent throughout the document?	
10	Are all terms, acronyms and abbreviations defined?	
11	Is the overall approach sound?	
12	Is the document well researched and based on proven prototypes?	

REQUIREMENTS REVIEW CHECKLIST

The purpose of this checklist is to provide guidance for verifying the quality of the system requirements against consistent criteria.

IV&V Engineer:_____ Date(s):_____

System:_____

Item #	Criterion	(Y/N) Record References to Non-Compliant Requirements
1	Completeness: All requirements have been allocated.	
2	Correctness: Each stated requirement represents something required by the system.	
3	Consistency: Each requirement is internally/externally consistent with other requirements.	
4	Traceability: The origin of the stated requirement is clear.	
5	Testability: a. An objective and feasible test can be designed to determine whether the requirement has been met. b. Requirements are specified in quantitative terms that are measurable. c. The requirement is annotated with an associated qualification method.	
6	Understandability: Terminology is understandable and consistent. Notations are accurate.	

REQUIREMENTS REVIEW CHECKLIST

Item #	Criterion	(Y/N) Record References to Non-Compliant Requirements
7	Nonambiguous: a. The stated requirement has only one interpretation. b. The use of vague qualifiers is avoided (e.g., "... to the extent practical ...", "A minimum of ..."). c. The requirement has a unique identifier. d. Proper requirements language is used (i.e., "shall").	
8	All relevant equipment is identified and described (e.g., processors, memory, interface hardware, and peripherals).	
9	The software role in the system is explained. Major software functions are described in relation to system operation.	
10	The hierarchy of functions (or the organization of objects) is supported by enough data to demonstrate traceability of inputs and outputs.	
11	The document structure is consistent with the hierarchy of functions (or partitioning of objects).	
12	The data flow is consistent with inputs and outputs. Sources and destinations for all data are identified.	
13	Each identifiable requirement defines a testable function (e.g., makes a decision, controls a subordinate function, or moves or computes data).	
14	Requirements specify behavior under normal and abnormal conditions.	
15	Sequences are clearly defined.	

REQUIREMENTS REVIEW CHECKLIST

Item #	Criterion	(Y/N) Record References to Non-Compliant Requirements
16	Accuracy/precision are stated where necessary.	
17	There are no unwarranted design constraints.	
18	Performance characteristics are reasonable.	
19	Resources are budgeted realistically (e.g., memory, throughput, response times, data storage).	
20	The scope of the requirements is consistent with software estimates, schedules, and support plans.	

PRELIMINARY DESIGN REVIEW CHECKLIST

The purpose of design reviews is to determine whether all software requirements have been translated into a viable software design. Generally, software projects have two design phases: top-level and detailed design. The following checklist applies to the high level design.

IV&V Engineer:_____ Date:_____

Project: _____ Phase:_____

Item #	Criterion	(Y/N) Record References to Non-Compliant Items
1	The functional [or object] partition is consistent with the Software Requirements and Interface Requirements	
2	Security, Reliability, Maintainability, Availability issues have been addressed	
3	Each CSC has a single well defined purpose	
4	Software Requirements Specification and Interface Requirements Specification allocated to CSC	
5	The Requirements Allocation Matrix has been updated to reflect allocation of requirements to CSCIs including COTS if applicable	
6	All CSC level inputs, outputs, functional control and sequencing should be defined	
7	Internal (CSCI and CSC) interfaces and external interfaces are defined	
8	COTS applications and interfaces are defined	
9	Human factors have been addressed where relevant	
10	Contractor CM procedures and controls are in place	

CRITICAL DESIGN REVIEW CHECKLIST

The purpose of design reviews is to determine whether all software requirements have been translated into a viable software design. Generally, software projects have two design phases: top-level and detailed design. The following checklist applies to the detailed design.

IV&V Engineer:_____ Date: _____

Project:_____ Phase: _____

Item #	Criterion	(Y/N) Record References to Non-Compliant Items
1	Each module has a single, clearly stated function	
2	Units are named according to applicable conventions	
3	There is a software requirement from which the need for this function arose	
4	There is no superfluous processing	
5	No necessary processing is missing	
6	There are no other types of identifiable errors in logic	
7	There are no possible error conditions that were not provided for	
8	Unit interfaces are consistent and well defined	
9	Software requirements can be traced to code	

PROCESS AUDIT (CONFIGURATION MANAGEMENT) PROCEDURES SAMPLE CHECKLIST

The purpose of a process audit is to ascertain, based on objective evidence, that approved plans and procedures have been implemented and are being followed.

IV&V Engineer:_____ Date: _____

Project:_____ Phase: _____

Item #	Criterion	(Y/N) Record References to Non-Compliant Items
1	There are documented processes in use that provide timely, comprehensive, and accurate processing, reporting, and recording of approved changes to controlled components.	
2	There are documented processes that provide comprehensive implementation of approved changes and dissemination of corrected documentation and software changes.	
3	There are documented processes in use that provide accurate reporting and recording for the status of all proposed changes and change resolution.	
4	There are documented processes in use that provide verification and implementation of identification, change control, and status accounting of descriptive documentation and software materials.	
5	There is an internal baseline for documentation. (In the "Notes" section, record contract items (i.e., CDRLs) which have been placed under internal control. Note any items which should be under control, but are not, as of the audit date.)	

PROCESS AUDIT (CONFIGURATION MANAGEMENT) PROCEDURES SAMPLE CHECKLIST

Item #	Criterion	(Y/N) Record References to Non-Compliant Items
6	There are documented processes in use which govern the identification (titling, labeling, numbering, and cataloging) of all software documentation and software materials:	
	a. Identification denotes the component to which it applies.	
	b. The purpose is described.	
	c. The applicable baseline is defined.	
	d. The serial, edition, and change status is identified.	
	e. The compilation date for each deliverable software component is identified.	
	f. There is visual and machine readable identification for all delivered software media that permits direct correlation with delivered documentation.	
7	There are documented processes in use that govern internal control of all documents and software materials in the development support library.	
8	There are documented processes in effect that require bringing each component of the software under configuration control.	
9	There is a documented process that governs the establishment of the Configuration Control Board.	

PROCESS AUDIT (CONFIGURATION MANAGEMENT) PROCEDURES SAMPLE CHECKLIST

Item #	Criterion	(Y/N) Record References to Non-Compliant Items
10	The CCB operates, with the proper membership, as described in the documented process.	
11	There are verifiable records indicating that all required CCB members were in attendance at meetings.	
12	There are documented processes that define the methods and format for submission of problem reports for problems detected in activities and products.	
13	There are documented processes in use that define the methods for processing problem reports for software and documentation which has been placed under configuration control.	
14	There are documented processes in use that control the preparation and dissemination of changes to documentation to reflect approved and implemented changes.	
15	There are documented processes in use that require the generation of a problem report when changes are made to software and baselined documentation.	

CODE REVIEW CHECKLIST

The purpose of a code review is to determine whether the software design has been correctly implemented in code that adheres to the programming standards and conventions. The following checklist suggests evaluation criteria and questions to consider when reviewing the code.

IV&V Engineer:_____ Date: _____

Project:_____ Module(s):_____

Item #	Criterion	(Y/N) - Record References to Non-Compliant Items
1	Does the module (unit) have a single, clearly stated function?	
2	From which software requirement(s) did the need for this function arise?	
3	Does the documentation adequately describe the processing, data, and interfaces of this function?	
4	Is the developer name, date of development and description of module function or code change included in the comments? Are comments adequate and accurate in describing the processing? Do comments concentrate on what is being done as opposed to how it is being done?	
5	Are there control flow errors?	
6	Is there superfluous or dead code?	
7	Is there missing code?	
8	Are there other types of errors in the logic?	
9	Are there possible error conditions that are not trapped?	
10	Are statements "commented out”?	

CODE REVIEW CHECKLIST

Item #	Criterion	(Y/N) - Record References to Non-Compliant Items
11	Does the code conform to SFA Programming Standards and Conventions (if applicable)? Does the code adhere to the C or applicable coding standards?	
12	Has the code under review been checked into the FSA CM code management tool?	
13	Has the Unit Test Plan (UTP) for the code under review been completed?	
14	Does the module achieve its goals as stated in the design documentation?	
15	Does the module generally follow the PDL in the design documentation?	
16	Are there obvious style problems that affect readability or maintainability?	
17	Is the file too long (>500 lines) or contain too many functions?	
18	Is there duplicate or similar code that could be combined into a general-purpose function?	
19	Are there obvious code in-efficiencies (opening and closing a file multiple times)?	
20	Are there better ways to accomplish the same results provided by the code?	
21	Does the function return correct information to the caller in all cases?	
22	Error cases not handled correctly (including caller program ignoring error status returned by called function)?	

CODE REVIEW CHECKLIST

Item #	Criterion	(Y/N) - Record References to Non-Compliant Items
23	Do error messages provide enough information for an operator to understand the problem being reported?	
24	Has a code review results file been created and checked into code control tool?	
25	Has the CSCI Lead or his/her designee followed up to ensure that any discovered defects are addressed prior to the completion of testing?	

UNIT TESTING REVIEW/AUDIT CHECKLIST

The purpose of this checklist is to provide guidance for assessing the quality of unit testing.

IV&V Engineer:_____ Date:_____

Project:_____ Modules:_____

Item #	Criterion	(Y/N) Record References to Non-Compliant Items
	Unit Test Plan Audit	
1	Is the purpose/objective of the test stated and it is applicable to the unit in question?	
2	Is the requirement reference traceable to the unit?	
3	Is the data recording and analysis method defined ?	
4	Are all required software items and tools identified and available?	
5	Is the version of each software item and tool identified?	
6	Is regression analysis defined in case of errors and code update?	
7	Were any tools employed (test path coverage)?	
8	Is the test plan consistent with the prescribed process defined by the development team?	
9	Was the test plan subjected to a peer review?	
10	Will the test be executed by someone besides the author?	
11	Will the test be executed by someone besides the author?	

UNIT TESTING REVIEW/AUDIT CHECKLIST

Item #	Criterion	(Y/N) Record References to Non-Compliant Items
	UNIT Test Results Audit	
12	Was the test plan approved prior to the start of testing?	
13	Are test results retained in the application folder?	
14	Is there a test report for this unit?	
15	Were the required higher level units available?	
16	Were the results reviewed by an independent evaluator ?	
17	Is there evidence of source code review prior to the start of testing ?	

SOFTWARE DEVELOPMENT FOLDER CHECKLIST

The purpose of a software development folder is to track development information for the effort for development, maintenance and training purposes.

IV&V Engineer:_____ Date:_____

Project: _____ Module(s):_____

Item #	Criterion	(Y/N) Record References to Non-Compliant Items
1	The Software Development Folder (SDF) procedures are documented in the Software Development Plan (SDP) or available on EDNET.	
2	Each SDF file contains a cover page describing the description and content of file.	
3	There is a standard format consistent between the folders and the module names and identifiers are correct. Code follows FSA coding standards: (e.g. no XML.)	
4	The SDF contains the following sample Concept Design Phase information as appropriate including: general concept data, results of Concept Design Review, action items and concept documentation in one generic folder.	
5	The SDF contains the following sample System Requirements Analysis phase data including the requirements database or links, System Requirements Review actions and notes and requirements documentation.	

SOFTWARE DEVELOPMENT FOLDER CHECKLIST

Item #	Criterion	(Y/N) Record References to Non-Compliant Items
6	The SDF contains the following sample preliminary and detailed design information as appropriate including: Hierarchy Diagrams, functional flow diagrams, PDL, Specifications, PDR and CDR data, object oriented diagrams, requirements allocations, Human Computer Interface data, event trace data, design notes action items, and unit test plans.	
7	The SDF contains the following Build and Test information as appropriate including: source code, unit test procedures and results, build test procedures, requirements trace data, and defect tracking.	
8	The SDF contains the following Integration and Acceptance Test information including updated source code, test procedures, requirement allocations, defects, updated design information, TRR notes, test results, and regression test procedures and results and deployment data including Production Readiness Review action items if applicable.	

TEST READINESS REVIEW CHECKLIST

The purpose of a TRR is to assess readiness to proceed to the Integration or Acceptance Test. This checklist provides guidance for assessing these reviews.

IV&V Engineer:_____ Date:_____

Project:_____ Phase:_____

Item #	Criterion	(Y/N) Record References to Non-Compliant Items
1	Software Test Plan Submitted and Approved	
2	System Integration or Acceptance Test Plans submitted and approved	
3	Configuration of System under test documented	
4	Draft Version Description Document (VDD) submitted three working days before TRR	
5	Requirements/Test Case Traceability completed	
6	Developmental Software under CM Control	
7	Hardware/System Software under CM Control	
8	COTS Software under CM Control	
9	Test Procedures and Test Data under CM Control	
10	All applicable deviations/waivers submitted and approved	
11	Test Environment established	
12	Test specific software developed	

Item #	Criterion	(Y/N) Record References to Non-Compliant Items
13	Test Dry Runs completed and results submitted. Results included the number of dry run requirements passed, failed, and not tested	
14	Test Schedule prepared	
15	Prior milestones completed (e.g., CDR) in that all of its exit criteria is satisfied and all Action Items responded to	
16	Security requirements satisfied	
17	Entrance Criteria for the Integration/Acceptance/Alpha/Beta Testing established	
18	Exit Criteria for the Integration/Acceptance/Alpha/Beta Testing established	

ITEM #	ASSESSMENT REQUIREMENT FOR WEB-BASED APPLICATION	(Y/N) COMMENTS
	Have web accessibility guidelines been established?	
	If web accessibility guidelines have not been established, is there a timetable for doing so?	
	Are there procedures in place to ensure that maintenance of the web site and it's contents follows the established accessibility guidelines?	
	If not, is there a timetable for establishing these procedures?	
	Is clear and detailed information provided on the component-level home pages or on the agency wide home page for improving the accessibility of the web site for persons with disabilities?	
	If not, is there a timetable for providing this?	
	Is there an e-mail address allowing people with disabilities to inform the agency of accessibility problems and is this address advertised?	
	If not, is there a timetable for providing this?	
	Are meaningful text equivalents provided for all non-text elements such as images, multimedia objects, Java applets etc. to allow translation by assistive technologies?	
	If multimedia is used, is text captioning provided for all audible output?	
	If multimedia is used, is audible output provided for all important visual information?	
	If multimedia is used, are audio output and text captions synchronized with their associated dynamic content?	
	Is the page capable of being understood and navigated if users cannot identify specific colors or differentiate between colors?	
	Is the page viewable without style sheets or with the style sheets turned off or not	

ITEM #	ASSESSMENT REQUIREMENT FOR WEB-BASED APPLICATION	(Y/N) COMMENTS
	supported by the browser?	
	If style sheets are used, is the page designed so it does not interfere with style sheets set by the individual's browser?	
	If the page includes server-side image maps, are duplicate text links provided for all links within the server-side image maps?	
	If the page includes server-side image maps, has a timetable been established to replace the server-side image maps with client-side image maps except where regions cannot be defined with an available geometric shape?	
	If the page includes client-side image maps, does each map region have a text equivalent?	
	If the page contains data in tables and if any table has two or more rows (including header or data cells), does each cell provide identification of row and column headers?	
	Are "id" and "header" attributes used to identify table rows and headers within each cell? Newer screen readers can make use of these attributes.	
	Are tables used for formatting text? Note: Section 508 does not prohibit this practice, but discourages it where developers want to make their sites completely accessible.	
	If tables are used for formatting text, are methods used to minimize their effect on accessibility?	
	Are tables created with the use of the <PRE> tag? Note: Section 508 does not prohibit this practice, but discourages it.	
	If frames are used, is there meaningful text describing each frame?	
	Does the page include content that may cause screen to flicker with a frequency	

ITEM #	ASSESSMENT REQUIREMENT FOR WEB-BASED APPLICATION	(Y/N) COMMENTS
	between 2mhz and 55 mhz?	
	When scripting languages are used and the scripts affect content displayed to the user, is a text equivalent that is accessible to a screen reader provided for the user by the page or the script?	
	If the page uses applets, is the same information and functionality provided in an accessible format?	
	If the page uses other programmatic objects, such as Flash, Shockwave, etc, or otherwise requires the use of plug-ins or programmatic support for the browser, does the page include a link to the plug-in or programmatic item required for accessing the content of the page and is that plug-in or programmatic item itself accessible to people with disabilities?	
	If the page includes links to Adobe Acrobat files (extension .pdf), were those files created in a way that is likely to maximize their usability for people with disabilities? i.e. the files were created by "printing to .pdf" or scanned into .pdf and run through an OCR process and checked for accuracy?	
	If the page contains one or more electronic forms designed for online completion, does each form permit users of assistive technology to access the information, field elements, and functionality required for completion and submission of the form including all directions and cues?	
	If the page contains one or more forms designed to be completed online but that is inaccessible to people with disabilities in some respect, does the page include an accessible form or a link to an alternate accessible form?	
	If the page includes navigational links to	

ITEM #	ASSESSMENT REQUIREMENT FOR WEB-BASED APPLICATION	(Y/N) COMMENTS
	other web pages within the same website, is there a link allowing users of screen readers to skip over those links?	
	If the page requires users to respond within a fixed amount of time before the user is "timed out", is there a signal provided to alert the user that a time out is going to occur and is the user given sufficient time to request more time?	
	If the page being reviewed contains barriers to access for people with disabilities, is there an alternative text-only page that contains the same information and is updated as often as the reviewed page?	
	Has the page been tested by users with disabilities using assistive technology? i.e. screen reader, Lynx browser, IBM Home Page Reader	
	If not, is there a timetable for establishing these procedures?	

Appendix B

RISK MANAGEMENT PROCESS

ESTABLISH AND MAINTAIN A FORMAL FSA IV&V PROJECT RISK MANAGEMENT PROCESS

EXECUTIVE SUMMARY

The benefit of formalizing the FSA project risk management process will be:

- Identify issues that are actually project risks
- Keep all identified risks easily visible at all times rather than just those risks that are high profile at any one time.
- Encourage the creation of strategies to keep risks from turning into problems
- Track the risks to determine if the risk exposure changes with time
- Track the risks to ensure they are addressed
- Provide a framework for future improvement

process described here is not a complete risk management process, but is a simplified version modified for FSA. Like all risk management processes, it is a means of codifying behavior usually being done on an ad-hoc basis. As such, it will remain high-level and will be effective insofar as the project personnel assist in identifying project risks and, in particular, help identify strategies to deal with the risks. IV&V proposes to identify these risks as they surface during reviews, status meetings, conversations, etc. In many cases, these are risks already identified by the development team as issues. Once risks are identified, they are assigned a rating based on probability of occurrence, severity of effect, and risk exposure. Strategies to deal with the risk will be formulated where possible and the risk watch list presented to the development team for suggestions and modifications, thereby reducing the effort required of them. The risks will then be tracked through the project until addressed. IV&V will suggest mitigating strategies if none are identified by the project personnel. As with any process, this will be effective to the extent that it is useful to those affected by the outcome.

RISK MANAGEMENT BACKGROUND

Risk management is a technique that may be applied to many aspects of an information system. In the context of this document, it is a project management tool used to codify good management techniques meant to identify and control the risks inherent in any software development process.

Most software projects use risk management informally and this is usually referred to as “crisis management”. In crisis management, the mechanism for tracking and dealing with risks is ad-hoc and prone to error. Risks get attention when they become problems. It is only recently that risk management techniques have evolved and been elevated to the status of a formal process. In the past, for instance, life cycle methodologies often assumed that requirements can always be thoroughly determined or that users will fully participate or that project estimates can be accurately determined ahead of time. If these are not true, the textbook approach will often say that the project will not go forward until

the developers have received "sign-off". This often becomes a method of avoiding liability rather than a management tool. Most developers, however, know that projects do go forward under these circumstances and the risks attendant to them are handled individually and on an ad-hoc basis.

A common risk factor in software development is project estimates based on worst-case or best-case scenarios rather than realistic estimates by knowledgeable individuals. Another common risk is incomplete and/or changing user requirements. One expert's estimate of risk in the area of management information systems (Caper Jones) gives the following figures which, will probably be recognized by most of those involved in software projects:

Risk factor	Percent of Projects At Risk
Creeping user requirements	80%
Excessive schedule pressure	65%
Low quality	60%
Cost Overruns	55%
Inadequate configuration control	50%

Risk management is a process for identifying and prioritizing these potential problems, addressing them, and determining means of dealing with them. Done properly, risks are identified before they become problems in a continuous process that monitors the project and identifies risks as they occur. In reality, the QA process itself is a form of risk identification. As software development periods are increasingly collapsed, systems become more complex, and requirements are more difficult to firmly identify early in the life cycle, risk management assumes greater importance. The methodology known as Spiral Development, for instance, is predicated on constant risk management.

Identifying and dealing with risk is a strategy for reducing project uncertainty. Establishing risk management as a formal on-going process allows attention to be focused on the areas of greatest risk and allows plans to be formulated ahead of time to deal with these risks. It cannot, of course, eliminate risk. If a risk is not identified, for instance, a mitigation strategy cannot be formulated, but if a number of risks have been identified, tracked and dealt with, there will be more resources available to address unidentified risks if they do occur. Making project risk management a continuous process allows risks to be addressed and avoided and allows new risks to be identified and added to the watch list.

In addition to providing a day-to-day project management tool for FSA managers, this will lay the groundwork for a full-scale FSA project risk management process in the future.

ESTABLISHING THE FSA PROJECT RISK MANAGEMENT PROCESS

- Identify risks using a structure such as SEI's Taxonomy-Based Risk Identification. In the case of FSA, risks will often be identified through reviews, status meetings, and meetings with project personnel.
- Analyze risks, quantifying where possible:
    - The probability of a risk occurring
    - The impact of the risk to the project
        - Cost
        - Performance
        - Schedule
        - Support
    - The overall risk to the project using an Impact/Probability Matrix
- Plan for selected risks
    - Importance of risk
    - Information necessary to track the status of the risk
    - Assign responsibility for Risk Management activity
    - Identify resources necessary to perform Risk Management
    - Define approach for mitigating risk
- Track risks to determine if the risk exposure for a given risk changes with time
- Use mitigation to manage risk

CONSTRAINTS

The open involvement of the project's managers and project personnel in identifying risks during interviews and reviewing the attached Risk Watch List is critical to the success of the process. This entails an investment in resources and cultural and organizational change over time. In the case of FSA, it is unrealistic to attempt a complete project risk management process at this point given the ongoing development and the development environment. It is possible, however, to implement the appropriate techniques to identify significant risks, provide a tracking mechanism, and establish a process for identifying proactive strategies.

ATTACHMENT A – RISK WATCH LIST

The Risk Watch List is the tool used for tracking project risks. The Watch List contains the identified risk stated in Risk Condition/Consequence format. That is, the risk is stated followed by the consequence to the project if the risk becomes a problem. In addition, there are columns for the estimated probability ("P") of the risk becoming a problem, the estimated impact ("I") on the project if the risk becomes a problem, and the Risk Exposure to the project, which is a product of the Probability and the Impact and is determined by the Probability Matrix in Attachment B.

- The Watch List provides a tracking mechanism by identifying events ("First Indicator") that indicate a risk is becoming a problem, the approach determined to mitigate or control the problem, the person responsible, and the date by which the mitigation approach is to be implemented.

- This sample Risk Watch List contains examples of current issues that could be identified as risks. The probability, impact, risk exposure, person assigned as responsible, and the due date are for purposes of illustration only.
-
-

- ATTACHMENT B – PROBABILITY MATRIX
- The risk exposure for any given risk is determined by using the estimated probability of the risk and the estimated impact of the risk to derive a weighted exposure from the matrix. This provides a risk exposure factor based on both probability and impact.

TEST READINESS REVIEW CHECKLIST

- EXAMPLE
- ATTACHMENT A - RISK WATCH LIST
-

RISK WATCH LIST						
ID #	Risk - Consequence	P	I	Risk Exposure	First Indicator	Risk Mitigation Approach
1	Conversion mapping is incomplete; 50% of critical fields mapped; remainder not mapped/ Cannot begin conversion without completed field mapping table	1	3	Medium	None identified	Proceeding with development to be ready for testing. Will back fill remaining fields as mapping is completed.
2	Current contractor not cooperating without task order. Cooperation after task order not certain / Will not be able to identify processes related to loan processing	1	2	Medium	None identified	Using second design solution to meet schedule. Issue task order and meet with current contractor to review responsibilities.
3	Not receiving necessary support from key constituents / Cannot complete requirements	3	3	High	Requirements not complete at Requirements Review	None identified
4	Reports requirements not completed / Will not be able to build all reports until requirements complete	2	3	Medium	None identified	Prioritize incomplete report requirements and complete requirements for critical reports with end users by due date. Complete requirements for non-critical reports by 7/01/01.
5	Production files for stress testing are not available / Will not be able to duplicate actual peak production volumes; may leave system open to performance problems in production	2	2	Medium	File not available at TRR	Investigating means of simulating production transaction volumes

P = Probability of risk becoming a problem

1- Improbable

2 – Probable

3 - Very likely

I = Impact if risk becomes a problem (determined by exposure matrix

1 – Negligible

2 - Marginal

3 - Critical

4 - Catastrophic

* Risk Exposure comparing Probability and Impact)

1,2- Low

3,4- Medium

5,6- High

- ATTACHMENT B - RISK EXPOSURE MATRIX
-

RISK EXPOSURE MATRIX				
		Probability →		
		3- Very Likely	2 - Probable	1- Improbable
Impact ↓				
	4 - Catastrophic	6 High	5 High	4 Medium
	3 - Critical	5 High	4 Medium	3 Medium
	2 - Marginal	4 Medium	3 Medium	2 Low
	1 - Negligible	3 Medium	2 Low	1 Low

-